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The Astronomical Fraternity of the World

By DAVID B. PICKERING

PART XV

Somewhere between San Jose and San Francisco, in the town of Morgan Hill, California, live Mr. and Mrs. Charles E. Barns. As the author of that splendid astronomical hand-book, "1001 Celestial Wonders," Mr. Barns is known and respected by an army of aspiring amateurs, but by the members of the American Association of Variable Star Observers he is held in special esteem for all that he has done to aid that organization. With the help of the late Mr. Skaggs, he has furnished the Association with their membership, library, and lantern-slide catalogues for years, giving both his time and means to that end. He is an able poet and we recall the verses he contributed to the Memorial

FIGURE 1
MR. CHARLES E. BARNS, IN HIS LABORATORY
AT MORGAN HILL, CALIFORNIA

which the A.A.V.S.O. issued after the death of Professor E. C. Pickering. Mr. Barns had been a newspaper man in New York, but many years ago he and Mrs. Barns pulled stakes and came to settle in the Santa Clara valley. Their cottage stands in an orchard of plum trees and I believe Mr. Barns' "business" is growing and marketing plums. We stopped to see them during our motor trip to San Francisco, after visiting Mt. Hamilton late in May, 1931, and for the best part of a day were treated to an example of traditional western hospitality.

Mr. Barns is a portly, spectacled gentleman, whose iron-gray hair, a

little thinned at the temples, is brushed straight back from his high forehead. He was quiet, deliberate and methodical, and never without the long cigar which seemed a necessary part of him. Dressed in sack coat and silk vest, he had more the appearance of the typical New York business man than the western fruit farmer. But Mrs. Barns, with a colorful kerchief bound turban-wise about her hair, gave the tropical touch which the picture seemed to require.

We had lunch with them in their sunny dining-room, and then Mr. Barns showed us his twin work-shops at the rear of the cottage. In one he grinds his mirrors and makes other optical accessories and in the other carries on his book-making avocation. In the latter were stored the plates of type for the "1001 Wonders," every stick of which, he had set himself as a labor of love.

Later in the afternoon, Mr. and Mrs. Barns took us to call upon friends in the valley; Kellog, the famous imitator of bird calls, and Mrs. Achilles, the daughter of the man who is reputed to have given George Eastman his start in the photographic world. We left them waving good-bye as we pulled away down the one-track country road that led to the San Francisco highway.

It was another of those fleeting, friendly incidents.

There was a week of bustle and sight-seeing in the big city, a week of being entertained by old friends and new, before sailing for Honolulu, where we were to spend a fortnight before continuing on to Japan. We sailed from San Francisco on June 11, aboard the Tatsuta Maru of the N.Y.K. Line, out through the Golden Gate, bound for our first Oriental adventure.

Aboard ship we made contacts with the strange, mystical people of whom we were to see much but learn little, before our return to America.

Here we had opportunity to try an occasional Japanese meal and practice the trick of using chop-sticks, a knack that came more easily to me than to Mrs. Pickering. We had an occasional language lesson from our steward, Uyeda Tsunckichi, and from fellow passengers among the Orientals, but, alas, how little of this we retained. I think we can still count up to ten and remember that "Rioku Cha" means green tea, and that "Say Onara" is good-bye. And in what other language could this phrase sound so wailingly sad?

Our stay in Hawaii was uneventful astronomically, except for a broadcasting which I was asked to make for a local newspaper in Honolulu and which I was assured could be heard in Australia, and for the glory of the full, June moon rising above Diamond Head, over Waikiki Beach, as seen through the glamorous palm trees. To sum up, when Mrs. Pickering is asked what land, of all those we have visited, she likes best, she murmurs dreamily, "Hawaii!"—and that goes for me too.

It was June 30, when, with leis about our necks, we boarded the Asama Maru to continue our journey. These Japanese boats were

17,000 ton, Diesel driven motor ships and luxuriously modern. There we made new friends and met others who had been our companions on the Tatsuta. It was on this trip that we lost an old and familiar friend, our National Holiday, for on July 3, we crossed the 180th meridian and passed to July 5 without hearing a fire-cracker. But the Captain was good enough to allow us to "call it a day" after 3:00 P.M. of the third, and in honor of his American guests made the decks gay with bunting and booths. He also made what I feel sure was to have been a felicitous speech after dinner, but neither the Americans nor his countrymen could understand his English. Our landing at Yokohama on July 9 was as full of thrills as is usual when port is made in a new and strange part of the world.

But the season of rain had begun, in a land where it rains two-thirds of the time, and the Kingdom of the Rising Sun looked very gray. Earlier in the day I had received a radiogram stating that W. W. Campbell would meet us on board at Yokohama. We had recently met Professor Campbell at Mt. Hamilton for the first time, and why he should go to this trouble for mere acquaintances, and how in the world he had reached Japan ahead of us, and why we hadn't been told of his intended sailing, all troubled us more than a little. Upon the arrival aboard of a boatload of men who met us down the bay, a short, stocky gentleman handed me his card and I read the name William Wallace Campbell. A voice with an English accent was explaining that the donor of the card was the representative of the Grace Line in Japan and had been advised by his people of our coming. He had flown 500 miles from Kobe to meet the ship, and give us greeting to Asia. When the mental fog had cleared we accepted Mr. Campbell's invitation to show us some of the sights even before we had secured hotel accommodations. Later, in Kobe, we met Mrs. Campbell and enjoyed the hospitality of their home, and (to make the coincidence still more unusual) learned that their married daughter was a next door neighbor of my father in Summit, New Jersey. They became our very good friends and did much to make our stay in Kobe enjoyable.

Then came days of shopping on the famous Benten Dori; of sightseeing and rickshaw riding, all in the rain. It still poured the day we took train for Kobe. Although we had hours to wait in the railway station, we enjoyed every minute of it. The Emperor's train from Tokyo passed through and many frock-coated silk-hatted gentlemen stood in line on the rain-drenched platform and bowed low as it sped by. About the station and the muddy plaza surrounding it was a kaleidoscope of native life. Women with their colorful paper umbrellas stepping daintily through the mud on their high, wooden getas; men with babies strapped to their backs; men and boys on bicycles everywhere. In Japan there seemed to be more babies, more bicycles, and more baseball than anywhere else in the world.

The first-class coaches of the train, finished in black laquer and gold,

surpassed our Pullmans in richness of decoration, the most conspicuous difference being the row of polished, brass cuspidors set into the center of the aisle floor at convenient distances. Japanese gentlemen in western dress would enter the car, exchange their business suits for kimonos and, removing their unbearable leather shoes, sit massaging their bare feet, across the aisle from us.

From the windows we watched the rice paddies and tea groves, and the ox-carts which the peasants drove along the muddy roads. The morning after our arrival in Kobe, Japan's second largest sea-port, there came a messenger from Mr. Iba, whose home and observatory are some miles from the city, deploring the fact that business was taking him away for several days, but urging us to visit his home and see his equipment. I have little doubt that Mr. Iba would be considered Japan's leading amateur astronomer. His means have enabled him to acquire a collection of instruments that would be the envy of many observatories. The results of his research into the records of ancient Chinese and Japanese celestial phenomena have been published in part in POPULAR ASTRONOMY.

Our hours and days were so filled, however, that we could not arrange to make this visit much as we wished to do so. It was our only chance to see an independent private observatory in Japan, but we had to miss it. We wrote Mr. Iba how badly we felt about it. After two days in Kobe, we arrived in Kyoto, the ancient capital of the Empire, on July 16. At the spring meeting of the A.A.V.S.O. at Mt. Holyoke, in 1923, we had met Professor Issei Yamamoto, Director of the Kyoto University Observatory, and had looked forward with pleasure to seeing him again. Much to our disappointment he had written that it was necessary for him to be out of town at the time of our visit. However, on the morning after our arrival, we were summoned to the lobby of the hotel to meet the Assistant Director of the observatory, Dr. Joe Ueta. Kyoto is about the latitude of Charleston, South Carolina, and July is the season of rains. It was sweltering and humid and the Japanese detest the heat and each carries his fan as religiously as the Englishman carries his umbrella. On that particular morning, I was dressed in the most careless of negligees, but Dr. Ueta wore perfect western morning dress—cutaway coat, striped trousers, wing collar, and the white linen line bordering the vest. How he must have suffered! He is small of stature, and very dark, and though rather sober there was evidence of humor and even merriment about the generous mouth and bright eyes, but this he would try to suppress by covering his mouth with his hand in a gesture of embarrassment. We liked him a lot from the first. He apologized for coming alone, but explained that Mrs. Ueta was indisposed, and invited us to be their guests next day in a tour of the city, and a visit to the observatory. They called for us at nine next morning in a big Willys-Knight car. Both Mrs. Pickering and I at once fell in love with Mrs. Ueta. She is small, plump, dark and round-faced with her straight black hair cut in the only

"bob" we had seen on the islands. Hers was the natural beauty of the average Japanese woman, and nowhere at home or abroad have we seen so many beautiful women as in Japan. She was charming, vivacious, and always smiling. She was dressed in native costume of quiet color, except for the brilliant obi and the white stockings which Japanese ladies seem to prefer.

FIGURE 2
DR. AND MRS. JOE UETA

Again we set out in drizzling rain and visited the Imperial Park, with its old palace, "Gosho," surrounded by high, red-tiled walls. The original palace was built by the Emperor Kwammu in 794 but it and many of its successors were destroyed by fire. The present edifice was built by Meiji, grandfather of Hirohito, the present Emperor, in 1858, and was occupied only until the Restoration in 1868.

From there we drove to the so-called Detached Palace, "Nijo-Rikyu," or Nijo Castle, standing outside the Imperial enclosure, which was once the home of the Tokogawa Shoguns. It dates from 1569 and there, on April 6, 1868, Emperor Meiji issued the edict for the subjugation of the Shogunate. We arrived at the Ueta home about midday, a little new home, which they had occupied only about a month, and which stands at the head of a narrow street which runs close to the side of the University grounds. We removed our shoes in the "step-off" room, or vestibule, outside the front door, and in stockinged feet went upstairs to the large, unfurnished living room, unfurnished except for the "tokomura," the small alcove platform, where, below a scroll inscribed by a Buddhist priest, stood a low tabouret holding a vase with a single flower. The sliding glass wall panels, not paper, for this was a modern house, were wide open, giving the room a border of trees and garden shrubbery. Dr. Ueta had changed to Oriental costume by the time tiffin was announced and in his Oxford-gray kimono looked even more dignified than when wearing those uncomfortable clothes of the western world, which are decreed as day dress for Japanese men. With toes extended

behind them and with knees together, Dr. and Mrs. Ueta sat on their heels, while we sprawled as best we could on the soft matting. We ate from individual tabourets, about five inches high, served by a grinning maid who was most of the time on her knees. There were bowls of thick soup containing meat and vegetables, which we held just below the chin, drinking from the bowl and eating the solid food with our chopsticks. Then there were fish cutlets, a dish of rice and vegetables with Japanese onions, then more fish, each bit curled up in odd fashion. There was the inevitable tea to begin the meal and a different variety was served again at the end, in minute cups. There was fruit—loquats—and red wine and beer, all interspersed with good-natured laughter at the efforts of the awkward foreigners. Mrs. Ueta thought that she would like to observe variable stars, with an available 3-inch glass, while her husband was busy with some of his night work, and I took a picture of her as she signed her application for membership in the A.A.V.S.O., with her soft-sounding name, "Terue Ueta." Dr. Ueta, having changed to a cool, linen suit, then took me to see the University. We crossed the dirt campus, passing the gray buildings where about 5,000 students were engaged in seeking knowledge, to the observatory, whose large dome houses a 10-inch Brashear mirror. There I was introduced to Assistant Professor Shinichiro Takeda, and Mr. Ikeda, the latter an ardent amateur, who gave me a copy of the Bulletin of the University, published irregularly, and a Year Book of the "Star Lovers Association," Vol. XI. This society was organized in 1920, and has more than a thousand members.

Later in the afternoon we were joined by the ladies and set out by motor to visit Mt. Kwasan. On a level clearing at the summit of this hill, for its elevation was only 220 meters, stands the Kwasan Observatory of the University of Kyoto. It was all quite new at that time, having been opened in October, 1929.

The narrow, winding road leading from the suburbs of Kyoto to the Observatory, had been built by the military as practice in engineering. Mt. Kwasan is surrounded by other hills of about equal height, and below, through the valley, runs the railroad to Tokyo. The several concrete buildings forming the observatory group stand about a central court. They are ultra-modern in architecture and well built for convenience and to facilitate observing. The administration building has a 30-foot dome, more than ample to shelter its 12-inch Cooke refractor. There are well-arranged computing rooms and a wide observing roof above the south extension, for the use of portable telescopes or other instruments. Opposite the main building, to the west, across the level dirt court, stand the other buildings of the group. There is the 18-inch Culver mirror belonging to Professor Yamamoto, which, with its mounting, was brought from England, and its concrete base is inclined at a distinct angle to compensate for the difference in latitude. The housing is pulled away from the telescope upon a two track extension. Next to

this stands the building containing the horizontal spectroheliograph, with its 16-inch coelostat by Grubb and 8-inch glass by Steinheil. This furnishes an image of the sun two inches in diameter. The mounting of that instrument had recently been made by Askamawerk, Bamberg, Germany. The same company also made the new 3½-inch transit instrument.

In a smaller building to the north, is a 7-inch Zeiss refractor with mounting by F. Sartorius of Göttingen. This telescope was purchased in 1910, for the purpose of viewing Halley's comet, during the director-

FIGURE 3
THIRTY-FOOT DOME OF 12-INCH COOKE REFRACTOR, Kwasan Observatory, Imperial University of Kyoto, Japan

FIGURE 4
EIGHTEEN-INCH CULVER MIRROR BELONGING TO PROFESSOR ISSEI YAMAMOTO

ship of S. Sinjo, who was, at the time of our visit, President of the University. There was a separate radio room where time signals were exchanged with Tokyo. As well as I can now recall, from notes made at the time, the members of the staff of the Kwasan Observatory in 1931 were: Director Professor Issei Yamamoto, so long a co-worker with Harvard Observatory in the investigation of variable stars; his assistant, Dr. Joe Ueta, who specialized in theoretical astronomy; Assistant Professors Toshima Araki and Shinichiro Takeda, both astrophysicists; Lecturer, N. Uyegima, who was engaged with solar observations; Assistant Astronomers K. Nakamura, mirror and lens maker, M. Morikawa, Secretary to the Observatory, M. Inaba and K. Yamamura. Among the graduate students were T. Shibata, who was computing orbits, and Mr. Miyazowa.

On our return to the main building, tea was served by the housekeeper in the reception room on the first floor. With us were six or seven members of the staff, all young and smiling, but very reserved gentlemen, their dark eyes sparkling with restrained enthusiasm. Probably the difficulty of the language accounted for their shyness. Mrs. Ueta, in her pretty costume and with her animated manner, was the most

sprightly member of the party. Dr. and Mrs. Ueta had recently returned from a trip around the world, and our talk disclosed that we three had attended the meeting of the American Astronomical Society at New Haven the previous December.

I then remembered seeing an Oriental couple at the meeting, but had no idea who they were.

We were interested to learn that we were the first foreigners to sign our names on the visitors' record of the observatory. After taking some group pictures on the steps at the observatory entrance, we went to the roof of the southern wing of the building to see some of Mr. Nakamura's handiwork. Mr. Nakamura was the tallest Japanese we had seen. His shoulders were broad and his face and forehead were broad, with high cheek bones and a large mouth that always smiled. He had been a member of the A.A.V.S.O. for many years and contributed faithfully to its reports. His fame as a maker of telescopes was by no means confined to Japan. He showed us one of his 5-inch instruments, a short focus mirror of the comet-finder type. It was a neat, compact affair, with squat wooden stand and iron tube.

All metal parts were finished in green with nickel trimmings. It sold, complete, for 160 yen ($80.00). In all, Mr. Nakamura had made 280 mirrors and over a dozen refractors. Several of his telescopes are owned by Mr. Iba. In the basement we saw in operation the remarkable machine that Mr. Nakamura employed for the construction of his mirrors. At the time, a round flat was being polished and a cam device gave an eccentric circular motion to the polishing tool which kept merrily at its job, having no muscles to tire or back to ache. Since our return we have learned of the death of Mr. Nakamura. Harvard will miss him, as well as Kwasan, and to the few foreigners, who, like ourselves, had the privilege of knowing him, his loss is especially felt. He was so young and virile, so quiet and kindly and of such high promise. We were invited by the staff members to dine with them at the University Club in Kyoto that evening. We left the observatory at sunset with Dr. and Mrs. Ueta, and the smiling gentlemen of the staff stood in a semi-circle about the steps of the porch and bowed low from the waist, their crossed hands touching the ground, in the very pretty manner of their country. The University Club, while not as elaborately furnished as some we have visited, had that familiar aura of learning, dignity, and ease that characterizes such establishments. The dinner was served in the western manner. There were chairs and knives and forks, with all of which some of the younger men may have felt a bit strange. However, as we had come to know each other better, there was much fun and laughter, and I recall an animated discussion as to the relative merits of various brands of cigarettes, the gentlemen of Kwasan extolling the virtues of the Japanese product known as the "Golden Bat." In the lounge, after dinner, we talked variable stars. I wanted to know of their plans for organized observing and to get assurance of their willingness to continue under the

Harvard régime. Language difficulties made it hard for either side to be clearly and fully understood, but I learned, somewhat vaguely, that the Kyoto and Tokyo groups were observing independently.

Some sort of plan had been broached for a national variable star organization, but it seemed that progress to that end might be retarded pending the decision as to which group should have control of its operation. I could only urge that, however the question might be settled, they would adhere to the Harvard standard of method and values, so that their observations would continue to be comparable with those of the rest of the world. Dr. and Mrs. Ueta, as they drove us to our hotel, made plans for more sight-seeing. With Mrs. Ueta, next day, we visited the "Golden Shrine" built 500 years ago, as a summer palace of the Shoguns, and originally covered with gold leaf. There at the side of a wood-enclosed lake we took part in the "Tea Ceremony." At another time we watched the celebration of the "Gion Matsuri," an age-old festivity in the form of a monstrous parade, which occurred annually on July 17, and in which those ancient, embellished vehicles called "Hokos" are trundled through the streets, while the "Yammas" are carried on the shoulders of the men. Tens of thousands of natives line the streets, business is, of course, suspended and trolley wires are cut to allow the "Hokos," with their tall decorations, to turn the corners. On the day we were leaving Kyoto, Dr. and Mrs. Ueta called at the hotel and Mrs. Ueta presented Mrs. Pickering with a beautiful paper umbrella and one of those huge, decorated lanterns that we had been craving ever since our arrival in Japan. So these good friends carried their hospitality right to the end of our visit and made our stay in Kyoto happy and memorable.

FIGURE 5
MEMBERS OF THE STAFF OF KWASAN OBSERVATORY
M. Morikawa, T. Shibata, M. Inaba, K. Nakamura, Dr. Ueta, Mr. Miyazowa

FIGURE 6
MEMBERS OF STAFF OF IMPERIAL OBSERVATORY OF UNIVERSITY OF TOKYO
Dr. M. Hasimoto, Professor K. Sotome (Director), and Dr. S. Kanda

How glad we shall be to see them again, if ever they appear from far away, at another of our astronomical meetings. It pleased us to learn, after our return to America, that Dr. Ueta had achieved full Professorship in the University.

There followed a visit to the site of a still earlier national capital, Nara, with its park of sacred deer and its shrines. A fortnight was spent at Miyanoshita, a famous resort nestling in a cup of the mountains not far from Fujiyama.

The owner-manager of the hotel at this place is Mr. Yamaguchi, who boasts the longest and most luxurious mustache in Japan. He was a charming host and soon became our good friend. During part of our visit there, Prince Chichibu, brother of the Emperor, and his Princess, occupied the table next to ours in the dining-room.

Then there was a sojourn in Nikko with its sacred red-lacquered bridge and its tombs of past Shoguns. It was not until the end of July that we reached Tokyo, once the ancient city of Yeddo, and, since 1868 the capital of Japan.

Greater Tokyo, with over 5,000,000 inhabitants, is exceeded in population only by London and New York. Not far from the moat that surrounds the walled enclosure containing the Emperor's palace, is the famous Imperial Hotel, and from there we arranged by phone to visit the Imperial Observatory, "Tokyo-Tenmogai," on the last day of July. The site of the observatory is about 16 miles from the center of the city in a suburban section of no great elevation, known as "Mitaka-Mura."

To reach this place we chartered a regal taxi and many times despaired of reaching our destination. Our chauffeur was continually losing his way, and after passing through many little villages where we had glimpses of rustic life and activities, we were finally deposited in front of the Administration Building in the observatory grounds. Here we paid our driver a hatful of yens for the time consumed on the journey, due to his ignorance of the local topography. We entered the large, low wooden structure, built in the form of a cross, with three wings extending from the entrance hall, and were soon met by Dr. Sigeru Kanda. We again felt that we had come across an old friend, for Dr. Kanda had been known to us for years through his membership in the A.A.V.S.O.

He is short and stocky and his round face is adorned with spectacles. His prominent teeth exaggerate his broad smile. Like all Japanese men, he wore conventional western clothes except shoes, for it is this part of the dress that seems most irksome to the Oriental, and is that which he most avoids. Personally I subscribe heartily to this idea of foot-freedom and ventilation which, had it been observed in the western world, might have saved people from the suffering which 90 per cent of them undergo because of our "civilized" mode of foot-dress. Dr. Kanda introduced us to Professor K. Sotome, Director of the Observatory, who is small and slight and of rather serious manner. We also met Dr. M. Hasimoto, a man of heavier type who, like Mr. Yamaguchi, wore a mus-

tache, but of less prominence. These three men showed us through the rooms of the building with their bare, white walls and high ceilings. There were the offices, the computing rooms, and rooms containing varieties of minor instruments. There was a Shortt clock and three clocks by Reifler, and we were told that they broadcast the time daily, at 11:00 A.M., noon, and 9:00 P.M. The observatory grounds, sparsely grown with tall, unkempt grass, cover about 20 acres. There is a main roadway, which passes the Administration Building in a north-south direction, and from this road run narrow lanes to the various instrument buildings that roughly form a rectangle about the main structure. Leaving this building, we passed down the roadway to the south and came to a small, domed structure which housed an 8-inch Zeiss telescope, with a 6-inch camera attached. There, also, was a new Zöllner photometer. The telescope was purchased three years before and was used for solar observation and stellar photography, as well as for observations for lunar occultations, under the program sponsored by Professor Ernest W. Brown of Yale. Beyond this building, at the end of the roadway, was the dome of the 20-year-old 8-inch Brashear telescope, remounted in 1925 by Warner and Swasey. We were told that its style was similar to that of the Bruce telescope which had been used by Professor E. E. Barnard. Dr. O. Oikawa used this instrument to make asteroid search-plates. To it was attached a 3½-inch solar camera. We then took a lane to the west and came to a building which housed a spectroheliograph with a 12-inch coelostat, built by Bambergwerk of Germany. Plates, made at the rate of one a minute, showed an image of the sun 2½ inches in diameter. We were shown some of these plates which had just been developed and were still in the hypo bath. The same building contains a long, high-dispersion spectrograph. Continuing to the west, we came to the Tower Telescope. This new Zeiss instrument has a steel mounting which is protected by a sightly brick and concrete structure. It was still unfinished at the time we were there. The telescope is of 14 meters focal length, with an 18-inch lens and 27-inch flats. The room that extends northward from the base of the tower, was intended to house a spectroscope. To the north of the Tower Telescope, and west of the Administration Building, stood the dome of the new 26-inch Zeiss refractor. It was my understanding that not only the instrument and its accessories but the building itself had been fabricated in Germany. It reached Japan in 1930, the year before our visit, and as yet had been little used. Dr. Hasimoto told us that he had made some observations of Eros with it. The wooden dome, 14½ meters wide, is supported on seventy-two 2-inch steel balls, and is built with a rising floor. A 15-inch guiding telescope with a focal length of 10 meters, (about a foot longer than the 26-inch) parallels the larger tube. The instrument weighs 13,000 kilograms, the movable parts 6,000 kilograms and the optical parts 80 kilograms. I understood that spectrographs had been ordered for use with this instrument. Between this and the Administra-

tion Building stands the transit house, with its curved roof, built in 1925. A large room contains a 9-inch instrument by Gautier. Back of the main building, at the northwest corner of the rectangle, is another transit house devoted to time observations. Here are a 6-inch Repsold, a 3-inch Bambergwerk, and another of 4 inches. It was evident that the majority of the instruments of the observatory were new or had been recently remounted, for the general destruction resulting from the earthquake of 1923, had made the complete reconstruction of the institution necessary. The predominance of German material, especially the new Zeiss equipment, indicated their desire to secure the best possible instruments. It recalled the statement that we had heard somewhere to

FIGURE 7
THE 18-INCH SOLAR TOWER TELESCOPE OF THE TOKYO OBSERVATORY

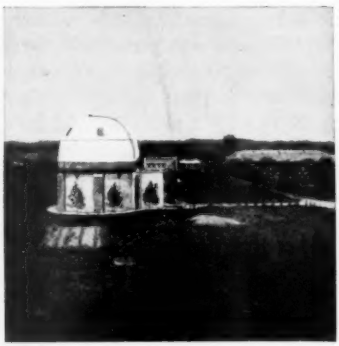


FIGURE 8
DOME OF THE 26-INCH ZEISS REFRACTOR, TOKYO OBSERVATORY
The Transit Building is at the left background, and the Administration Building at the right

the effect that Japan models her army after the French, her navy after the British and her scientific institutions after the Germans. I wondered at the time if our American astronomers who construct and equip their observatories, secure in the fact that future years will find them still intact and still functioning, realize the problems of the little men of Japan who live in the knowledge that the big earth-shock that is to raze their buildings and destroy their instruments, is somewhere just around the corner of time. Though it may be tomorrow or in a few years, the disaster will be upon them all too soon. Yet in spite of this, and with consummate courage, they carry on with a smile. Professor Sotome, whose specialty was solar research, has been on the staff of the Imperial Observatory for thirty years and for three years (in 1931) had been its Director. Other members of the staff, at that time, were Assistant Professor N. Fukumi, who was responsible for the preparation of the calendar; Astronomers Dr. M. Hasimoto, who had charge of all time

observations; Dr. Sigeru Kanda, who prepares the general almanac, a profound piece of work, and conducts the variable star program; Dr. O. Oikawa, who makes celestial photographs and who had discovered 20 asteroids in the five years previous; Dr. K. Tuzi and Dr. M. Miyadi whose particular lines of work we did not learn. There were also 23 others on the staff including assistant astronomers, computers, etc.

The majority of all these live on the observatory grounds. The site of the University, with its 10,000 students, is near Uena Park in Tokyo, and there several portable telescopes of 7-inch or less aperture are kept for student use.

It had been arranged that Mrs. Pickering and I, together with Professor Sotome and Dr. Hasimoto, were to be luncheon guests of Dr. and Mrs. Kanda, and so, a little later, we walked to Dr. Kanda's nearby cottage. From the "step-off" room, as we were removing our shoes, we could see into the dimly lit interior of the house, and noticed a shadowy object moving toward us across the floor. It was Mrs. Kanda, her face shy and smiling, who was approaching on hands and knees and bowing repeatedly until her forehead touched the floor. Our clumsy and embarrassed attempt to reach down and shake her hand spoiled the charm of her ceremonial welcome.

At the left, as we entered, stood an upright piano and on the music rack were studies in the familiar green and buff of the "Edition Peters," as well as compositions by Mozart and Beethoven. Astronomy and music—universal languages.

To our surprise the meal was served at a square table with chairs and tableware of western style. Mrs. Kanda did not join us there but served us throughout the lunch. As soon as we were seated, Mrs. Kanda set before each place a little oblong wicker basket in which lay a damp cloth, neatly folded. We followed, rather fearfully, the example of our host in applying this to our face, neck, and hands, allowing the resultant moisture to evaporate if and when it pleased. Then came tea, and more tea, six different kinds in as many varieties of containers, alternated with courses of soup, chicken, fish, and colored, gummy sweets. During the meal Dr. Kanda and I discussed variable star work, as best we could, using gestures when words failed. He showed me some of the copies of the A.A.V.S.O. charts in use by the twenty or more amateurs who report to him, which had been reproduced at the observatory, in black and white. In true Japanese manner, these were made to resemble the originals so accurately that I could tell at a glance by the characteristic formation of the figures and letters which of the originals had been made from Mr. Brocchi's tracings and which from mine. Dr. Hasimoto seemed especially interested in our methods for estimating the brightness of the variable, and asked so many questions that I got the impression the scheme was quite new to him. Dr. Kanda's private observatory is just back of the cottage, and after luncheon we went to look at his 4½-inch Steinheil telescope. The base of the equatorial mounting slides

on a track from beneath the housing. In the little observatory was a collection of variable star literature and a full set of POPULAR ASTRONOMY as yet unbound.

Professor Sotome invited us to see some of the sights of Tokyo with him in his private car, and his chauffeur drove us to the university grounds and to some of the old temples, stopping at last at a typical tea-room for more of the green beverage, before returning to the Imperial Hotel. Nothing more could have been done by those good people to make our visit memorable. Unfortunately, none of the three had very much English at his command, so that we may not have had as clear an understanding of all that we saw as had been the case at Kwasan. But they tried very hard to help us, and their humor and friendliness more than made up for some of the details we may have missed.

FIGURE 9

PRIVATE OBSERVATORY OF DR. S. KANDA

Professor Sotome, Dr. Hasimoto, Mrs. Kanda, Mrs. Pickering, Dr. Kanda

The day before we were to sail from Yokohama for Vancouver, we had just finished dressing for dinner in our room at the Grand Hotel, with the sunset light coming through our windows from across Yokohama Bay. A bell-hop announced callers in the lobby and there we found Dr. and Mrs. Kanda. They had surprised us by coming from Tokyo to bid us good-bye. With much embarrassment Dr. Kanda handed me two packages with the words, "Very poor gift." In a manner that must have been painful to our guests and exposed our ignorance of the niceties of Japanese etiquette, but with expressions of appreciation, we took off the wrappings, and found a pair of hand-carved and painted, embroidered fans for Mrs. Pickering, and a package of chopsticks for me. I remembered that I had mentioned that I was unable to find this particular kind in the stores. It was just too bad that we had

not learned sooner that in Japan one is not expected to open gifts in the presence of the donor.

We insisted upon their staying to dine with us on the open balcony that overlooks the harbor. There was necessarily little conversation, but occasionally a bit that was startling. We were telling of our recent visit to Lick and when Mrs. Pickering mentioned Dr. Aitken's name, Dr. Kanda looked up in surprise and said "Oh, the t is silent"—it was the only complete statement that he made. In the manner of their people they both expressed appreciation of our hospitality by the hearty, succulent sounds made while eating. I am sure we all enjoyed the fun of trying to make ourselves understood, and I have no doubt they were more conversant with our manners and customs than we were with those of Japan. Their courtesy and friendliness in coming so far with their gifts and their smiles made a climax to our visit in keeping with the earnest attention we had received from all the brotherhood whom we had met in Japan. Their letters would never again seem strange to us, like words from another world. Before this the Japanese astronomers had been vague personalities, reporting their observations across ten thousand miles of land and water. Now they had become friendly fellow dreamers, who loved the stars.

DAYTONA BEACH, FLORIDA, FEBRUARY 1, 1936.

The Detonating Fireball of May 26, 1935

By FLETCHER WATSON, JR.

A great fireball appeared over southern Vermont and central Massachusetts at approximately 8:53:54 P.M. (E.S.T.) on May 26, 1935. The newspapers of New England generously assisted in the collecting of data by requesting that all those who saw the spectacle should communicate either with the Harvard College Observatory or with the Amherst College Observatory. One hundred and twenty-seven letters were received at the Harvard Observatory from all parts of New England, the most distant being from Bath, Maine; Berlin, New Hampshire; Vergennes, Vermont. Letters were also received from New York City, and one report was sent from the Swedish ship "Kungsholm" which was south of Martha's Vineyard. Forty important letters from the western part of Massachusetts were received at the Amherst Observatory by Professor W. K. Green; these letters were later forwarded to the Harvard Observatory so that the data could be assembled in one report.

Of the 167 reports, fifteen gave the astronomical position or, upon later request, the measured values for the altitude and azimuth of the point first seen, the burst, and the disappearing point. The azimuthal values in the requested measures are satisfactory, but the altitudes are too low and tend to give a less steep path than that indicated by the astronomical observations. One of the important observations was made

from the Harvard Observatory in Cambridge by J. Cuffey and S. W. McCuskey who saw the beginning of the path and watched the fireball until it was hidden by trees south of west from their position. They made separate plots on a star map and their data have been used in fixing the slope and direction of the first part of the path. There were five reports in good agreement as to the azimuth of the bursting point; they fix the sub-bursting point near latitude +42° 19′.2, longitude W 72° 17′.4. Three of the reports were astronomical and a fourth, made with a restricted field of view, gave an accurate bearing on the burst point and its angular altitude. These four observations place the burst at an altitude between fifteen and sixteen miles; fifteen and a half miles has been adopted as the most probable value.

As reported from Southbridge, Massachusetts, the meteor had only a slight motion toward the east and downward; thus the region of the ground point was fixed. Another observation from Pawtucket, Rhode Island, gave the motion as vertical within 5 degrees. These two reports are in good agreement and fix the vertical plane of the motion. By combining the observation from Cambridge with several other apparent paths we determined the position of the radiant as N 38° W, altitude 53°, which at that time had the astronomical position of Right Ascension $9^h\ 50^m$, Declination +62°.5.

It is impossible to say exactly where the meteor first became luminous; the Cambridge observation shows, however, that it was luminous at a height of 65 miles above Halifax, Vermont. The point of disappearance is also uncertain, but above a point a mile southeast of Ware, Massachusetts, it was at a height of nearly seven miles.

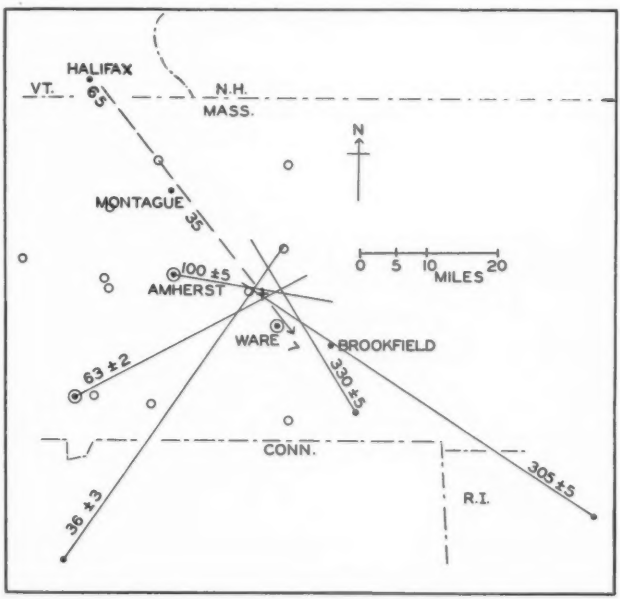
Any estimate of the velocity of this body must be very inaccurate as there was a large scatter in the reports of the duration of flight. A value of five seconds is adopted as indicating the order of the estimates. The total path from above Halifax to above Ware is 73 miles and the geocentric velocity was about 15 miles per second. When corrected for zenith attraction this value is reduced to 13 miles per second. The radiant was 126° from the apex of the earth's motion, and the heliocentric velocity was of the order of 28 miles per second. No significance should be attached to the fact that this value exceeds the parabolic limit.

The fireball first appeared as a bright meteor of red color. It rapidly grew brighter, the color changed to an intense bluish or greenish white, and at a height of 40 miles over Montague, Massachusetts, it began to disintegrate. Disintegration was evident from the streamers and sparks which appeared. At a height of 15.5 miles it burst and several pieces fell toward the ground. One large piece continued in the original path and disappeared at a height of about 7 miles. At the Amherst Observatory two distinct detonations were heard separated by two seconds, between 90 and 120 seconds after the burst was observed. Detonations were reported from many places in western Massachusetts; usually the description was "like the 'puff' of a distant rocket." At Leeds, a town

about nine miles west of Amherst, however, the detonations are reported to have caused windows and dishes to rattle. At Turner's Falls, almost directly under the early part of the path, the sound is reported to have resembled nearby dynamite blasts.

The brightness of the meteor in the later parts of its path was very great. At Oak Ridge (Harvard, Massachusetts) distinct shadows were cast and the magnitude was estimated as —10; at Cambridge it was estimated as —7; and at Amherst, as —10.

No meteorites were recovered from the fireball and there is little hope of finding any fragments of the object because of the heavily wooded nature of the country beneath its path. Contrary to press reports, no meteorites have been recovered from any fireball over New England in the last two years.



The diagram gives the azimuth and its probable error for the observations used in determining the sub-burst point (indicated by the cross). The dashed line represents the trace of the path, and the adjacent numbers give the heights at those positions. The open circles indicate the places from which detonations were reported.

The Date of the 2000th Anniversary of the Birth of Horace

By ALEXANDER POGO

On December 8 (Gregorian), 1935, many European and American universities, libraries, museums, periodicals, etc. paid tribute to Horace —born 1999 years ago. Quintus Horatius Flaccus, according to Suetonius, "natus est VI idus Decembris L. Cotta et L. Torquato consulibus"—in other words, he was born in the 65th year preceding the beginning of our era, on the 8th day of December, if we use the extrapolated Julian calendar, or on the 6th day of December, if we prefer to extrapolate the Gregorian calendar; the Julian-Day number corresponding to the day of the birth of Horace is J.D. 1698024. The choice of A.D. 1935 December 8 (Gregorian) as the date commemorating the Horatian bimillennium is objectionable on two grounds: first, the year is wrong, due to the common but erroneous assumption that M + N years separate a given date of the Mth year of the Christian era from the same date of the Nth year B.C.; second, the day of the month is wrong, on account of the confusion of Julian and of Gregorian anniversaries.

Figure 1 illustrates the correlation between the "current" years of the

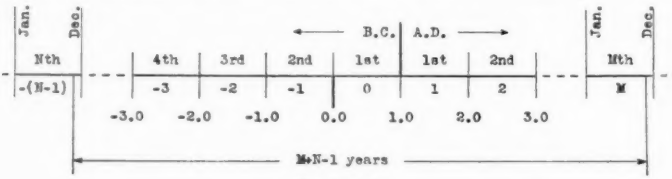


FIGURE 1

THE CURRENT-TIME SCALE OF THE HISTORIANS AND THE ELAPSED-TIME SCALE OF THE ASTRONOMERS.

historians, expressed in ordinal numbers, and the "elapsed" years of the astronomers, expressed by cardinal numbers (with or without a decimal fraction). The number of years separating a given date of the Nth year B.C. from the same date of the Mth year of the Christian era, is not M + N but M + N — 1 (all years beginning on January 1); thus, 1999—not 2000—years separate December 8 of the 65th year B.C. from December 8 of the 1935th year of our era.

There can be no disagreement concerning the year of the Horatian bimillennium—it is 1936, not 1935; the choice of the date, in December, 1936, depends, however, on the interpretation of the meaning of the term "anniversary." Does an "anniversary" imply the return of a Julian date in the Julian calendar, or the return of the earth to the same position in its orbit with respect to the vernal equinox, *i.e.* the return of a Gregorian date in the Gregorian calendar?

In the atrophied luni-solar calendar of the Romans, the ides of December fell on the 13th day of the month; the sixth day before the ides was, therefore, the 8th day of December. The date, December 8, represents, in the extrapolated Julian calendar, the position of Horace's birthday within the month of December of the 65th year B.C. Since the Julian calendar reform was introduced during the lifetime of Horace, the use of the extrapolated Julian calendar is quite appropriate. Table I

TABLE I

JULIAN BIMILLENNIUM

L = 254° . .	J.D. 1698024	or —64 Dec. 8 Julian (Dec. 6 Gregorian)
	730500^{d} =	2000 Julian years of $365^{d}.2500$
L = 269° . .	J.D. 2428524	or 1936 Dec. 8 Julian (Dec. 21 Gregorian)

shows that A.D. 1936 December 8 Julian (1936 December 21 Gregorian) marks the lapse of 2000 Julian years since December 8, 65 B.C.

The term "anniversary" may be interpreted as referring to the passing of the tropical year, or the return of the sun to the same longitude, and may, therefore, be expressed, with sufficient accuracy, by the return of the Gregorian date. Table II shows that A.D. 1936 December 6 Gregorian marks the lapse of 2000 Gregorian years since December 6

TABLE II

GREGORIAN BIMILLENNIUM

L = 254° . .	J.D. 1698024	or —64 Dec. 6 Gregorian (Dec. 8 Julian)
	730485^{d} =	2000 Gregorian years of $365^{d}.2425$
L = 254° . .	J.D. 2428509	or 1936 Dec. 6 Gregorian (Nov. 23 Julian)

Gregorian, 65 B.C., *i.e.* the 2000th return of the sun to the longitude 254°.

CARNEGIE INSTITUTION OF WASHINGTON,
DECEMBER, 1935.

Winter Solstice

At last the sun has reached the cedar spires
That end his pilgrimage upon the hill,
And all the clouds in benediction, now,
Stand robed in flame and for a moment still.

He long has passed the inky-fountained elms,
The black seaweed of oak, the beeches' pale
Fantastic lace . . . And now, the cedars reached,
He turns to trace again his ancient trail.

Thus moving like a giant pendulum
Along the tree-fringed hill, to south, to north,
He ticks the seasons there eternally
In mighty, golden journeys, back and forth.

FRANCES MORTON O'NEILL.

List of Nebulae and Star Clusters for Amateur Telescope Users

Compiled by J. B. DURYEA

With little or no knowledge of higher mathematics, few books, and a seemingly blank wall ahead, many amateur telescope makers find it difficult to obtain information about interesting objects for observation or how to locate them. This restricts them to a few well-known objects of which they tire in a year or so, and astronomy loses some good prospects.

Since making my 10¼-inch reflector in 1931 I have gradually built up a list of remarkable objects which I am sure many other amateurs could use to good advantage. The list given herewith is confined to nebulae and clusters. It is only a small list, but I expect to add to it as I learn more and observe more.

Intensive study of these celestial wonders is very recent, even though 103 of them were first catalogued by Charles Messier in 1781. Sir John Herschel constructed a much enlarged catalogue (the General Catalogue) in 1864. Later this led to the New General Catalogue by Dreyer in 1888. Nebulae and clusters are the beauty spots of the sky and they make a good entering wedge to the study of astronomy.

Setting circles, as well as clear, moonless nights, are necessary for these objects. Circles of some kind can be fitted to even the crudest mounting.

Explanation: Take No. 1 in the list: "224" is the number in the New General Catalogue (N.G.C.). "(M.31)" is No. 31 in Messier's catalogue. "Andromeda" is the name of the constellation. "0038 4050" is the location. The first four figures give the Right Ascension and the second four the declination. It reads: No hours Thirty-eight minutes Right Ascension; forty degrees fifty minutes North Declination ("north" because not italicized, or underscored). In No. 8, "(H.IV.26)" means No. 26 in Sir William Herschel's catalogue—the Roman numeral indicating the class of the object—I, II, III, bright, faint, and very faint nebulae; IV, V, moderate and very large planetary nebulae; VI, very compressed cluster; VII, compressed cluster of both large and small stars; VIII, loose cluster.

The distances given are the best surmises possible with present day knowledge. Many of these distances have been computed from observations of Cepheid variable stars in the globular clusters by Harlow Shapley and his able assistants. Others are from parallaxes and other methods used at Harvard Observatory and elsewhere. I have used the value of a parsec as 3.259 light years.

1. 224 (M.31). Andromeda. 0038 4050. The Great Spiral Nebula in And. One of the nearest and the largest of the known "Island Universes." Distance about 805,000 light years. An Extragalactic System such as our

own Milky Way System. It is possible that M.31, 32, and 33, together with our Galaxy and some others, may form a local group of Galaxies. M.31 is inclined about 15% from edgewise. Naked eye object. My 270 power shows it as a gaseous cloud.

2. 221 (M.32). Nebula in same lower power field with M.31.
3. 288 (H.VI.1). Sculptor. 0048 *2708*. Globular Cluster of 12 to 16 magnitude stars. Distance 47,250 light years. Bright but known as a loose cluster. Globular clusters usually appear thoroughly organized and in a state of quiet existence. Loose clusters appear as if in the process of organization.
4. 598 (M.33). Triangulum. 0129 3015. Spiral Nebula. Faint. Best with low power. Dist. 770,000 l.y. Nearest of the Island Universes except the two Magellanic Clouds.
5. 613 (H.I.281). Sculptor. 0131 *2949*. Large, bright Nebula.
6. 1039 (M.34). Perseus. 0236 4226. Loose Galactic Cluster. Dist. about 2,150 l.y. Best with low power. Just perceptible to the naked eye.
7. 1068 (M.77). Cetus. 0238 *0021*. Spiral Nebula. Small and hard to locate. Almost on the celestial equator.
8. 1535 (H.IV.26). Eridanus. 0410 1254. Planetary Nebula. Bright. Round. 11^{M} star at center. Low power.
9. 1904 (M.79). Lepus. 0520 *2436*. Globular Cluster. Center quite bright. Dist. 66,500 l.y. The principal characteristics of all globular clusters are strong central concentration, and richness in faint stars. Also they are at much greater distances than are galactic clusters.
10. 1912 (M.38). Auriga. 0523 3546. Compact Galactic Cluster of great beauty. In form of an oblique cross, with a pair of large stars in each arm. A field rich with stars. Dist. about 3,500 l.y.
11. 1960 (M.36). Auriga. 0531 3405. Open Galactic Cluster of 8-14^{M} stars. Regular arrangement makes it an object of great beauty. Dist. about 3,780 l.y.
12. 1952 (M.1). Taurus. 0529 2158. Gaseous Nebula. The famous "Crab Nebula" of Lord Rosse. "Presupposes a strong Irish imagination" to see anything resembling a crab. Messier discovered it in 1758 while following a comet, and this led to the formation of the Messier catalogue.
13. 1976 (M.42). Orion. 0531 *0526*. The "Great Nebula in Orion." One of the most awe-inspiring objects in the sky. It is a mass of seething material shining by reflected light from nearby stars. It is so tenuous that it compares with the air in a common light globe (a near vacuum) expanded so as to fill the Capitol Building at Washington. Dist. 1,800 l.y. Diam. about 25 l.y.
14. 2068 (M.78). Orion. 0542 0002. Gaseous Nebula, only two minutes north of the celestial equator. Requires good seeing.
15. 2099 (M.37). Auriga. 0547 3232. Galactic Cluster of more than 20,000 10-14^{M} stars. One of the richest and finest objects of this class. Moderate power. Dist. about 4,700 l.y.
16. 2168 (M.35). Gemini. 0603 2421. Galactic Cluster of exceptional beauty. The first sight of it is quite surprising. "A marvelously beautiful object." —Olcott. Dist. about 2,500 l.y.
17. 2169 (H.VIII.24). Orion. 0604 1358. Galactic Cluster. Triangular. Dist. about 2,500 l.y.
18. 2244 (H.VII.2). Monoceros. 0628 0455. Galactic Cluster. Looks like a great pearl. Contains 6^{M} star. Naked eye object. 6-14^{M} stars with a small pair near center. Dist. about 2,450 l.y.
19. 2287 (M.41). Canis Major. 0643 *2040*. Galactic Cluster. Naked eye object. Red star at center. This is probably the faintest object recorded in classical antiquity. Aristotle, 320 B.C. Moderate power. Dist. about 2,450 l.y.
20. 2301 (H.VI.27). Monoceros. 0647 0033. Galactic Cluster. Resembles three arms of a cross. Dist. about 2,450 l.y.
21. 2323 (M.50). Monoceros. 0659 *0814*. Brilliant Galactic Cluster. Blood-red star at center. Dist. about 2,600 l.y. Webb says of it: "Between Sirius and Procyon in a neighborhood where the Creator has 'sowed with stars the heavens thick as a field'."

22. 2360 (H.VII.12). C. Major. 0714 *1529*. Galactic Cluster of fascinating beauty. Nearly all 10M stars. Sir John Herschel said it was a mass of stars melting into a very rich neighborhood as though the Galaxy were approaching us. Dist. about 3,100 l.y.
23. 2392 (H.IV.45). Gemini. 0724 2105. Planetary Nebula. Herschel observed it as a 9th magnitude, others as an 8M or 7½M star, perhaps out of focus. Webb says it is "a conspicuous nebulosity."
24. 2420 (H.VI.1). Gemini. 0724 2145. Galactic Cluster. Quite wide but good for low power. Faint stars. Dist. about 10,400 l.y.
25. 2437 (M.46). Puppis. 0738 *1438*. Galactic Cluster of 10M stars. Dist. about 5,900 l.y.
26. 2447 (M.93). Puppis. 0741 *2304*. Bright Galactic Cluster in a rich field. 9-10M. Dist. about 3,580 l.y.
27. 2548 (H.VI.22). Monoceros. 0809 0533. Galactic Cluster. "Isolated, but bright and curious." Almost uniform 9M stars. Dist. about 3,100 l.y.
28. 2682 (M.67). Cancer. 0826 1206. Vivid Galactic Cluster of 10-15M stars. Beautiful. Dist. about 5,900 l.y. "Conspicuous centralization of red stars."—Shapley.
29. 2632 (M.44). Cancer. 0835 2016. Wide Galactic Cluster. The Praesepe of the ancients, and known as the "Bee Hive." Galileo counted 36 stars in it with his 2-inch telescope, power about 33. The ancients (300 B.C.) thought that Praesepe aided in weather prophecy—dimming at the approach of a storm. Dist. about 580 l.y. Too wide for field of 60 power. Note the two triangles.
30. 3115 (H.I.163). Sextans. 1001 *0720*. Nebula. Bright center. Probably a spiral. Seen edgewise. Very interesting. High power.
31. 3242 (H.IV.27). Hydra. 1020 *1814*. Planetary Nebula. High power. Amazing as a planetary. Circular. Nebulosity forms sparkling ring with two apparent clusters.
32. 3627, 3623 (M.66, 65). Leo. 1116 1326. Spiral nebulae. Faint, but very curious.
33. 4254 (M.99). Virgo. 1214 1452. Spiral Nebula. Bright. Wonderful. Circular. Compact nucleus. Same Decl. as M.88.
34. 4382 (M.85). Coma Ber. 1221 1838. Nebula. "Fair specimen of the many nebulae in this region."—Webb.
35. 4406 (M.86). Virgo. 1222 1323. Nebula. Very bright. In this neighborhood Lowe has seen seven nebulae in large low power field.
36. 4472 (M.49). Virgo. 1225 0827. Nebula. Bright, but rather hazy. Between two 6M stars. Spiral, seen edgewise. Dist. about 10,000,000 l.y.
37. 4501 (M.88). Virgo. 1228 1452. Spiral Nebula in a wonderful nebulous region. Probably inclined toward an edgewise position. Same Decl. as M.99.
38. 4565 (H.V.24). Coma Berenices. 1232 2626. Spiral Nebula, seen edgewise. Dark nucleus.
39. 4594 (H.I.43). Virgo. 1235 1111. Spiral Nebula, seen edgewise. Beautiful low power field.
40. 4590 (M.68). Hydra. 1235 *2619*. Globular Cluster of 12M stars (one red) easily resolved with 180 power. Same Decl. as H.I.138. Many Cepheid variables. Dist. 50,500 l.y.
41. 4826 (M.64). Coma Ber. 1252 2207. Spiral Nebula. Large with blazing nucleus. "One of the finest in the heavens . . . like a colossal pearl in a rayless void."—Barns.
42. 4649 (M.60). Virgo. 1239 1159. Nebula. Hazy and looks like a small star out of focus. M.59 in same low power field.
43. 5024 (M.53). Coma Ber. 1309 1835. Globular Cluster. Brilliant. Blazing center. 11-15M. Large number of Cepheid variable stars. Distance 59,000 l.y.
44. 5061 (H.I.138). Hydra. 1313 *2619*. Nebula. Bright though small, with round nucleus. High power. Same Decl. as M.68.
45. 5194 (M.51). Canes Venatici. 1326 4736. Spiral Nebula. The wonderful spiral of Lord Rosse. The first nebula recognized as whirling, and thus called the "Whirlpool Nebula." Its wreaths cannot be seen in small telescopes. Distance about 2,000,000 l.y.

46. 5272 (M.3). Canes Ven. 1338 2847. Globular Cluster of several hundred thousand stars. One of the very finest. Compact at center but very irregular at the edges. Dist. 40,000 l.y. Diam. about 60 l.y. 166 Cepheid variable stars, mostly short period, have been found in this cluster by Shapley. The variable stars found in Globular Clusters average 13 hours from maximum to maximum.
47. 5904 (M.5). Libra. 1514 0222. Globular Cluster of 9-15^{M} stars. Greatly compressed at center but very ragged at the edges. Contains a very large number of Cepheid variables. Dist. 35,200 l.y.
48. 6093 (M.80). Scorpio. 1612 *2247*. Wonderful Globular Cluster. Herschel called it the richest and most condensed mass of stars in the firmament. Dist. 57,000 l.y.
49. 6121 (M.4). Scorpio. 1618 *2620*. Loose Globular Cluster. Dim but worth observing. Contains many Cepheid variables. Dist. 23,500 l.y. One of the four nearest of the globulars. Some globular clusters appear loose but long exposure photographs bring out dim stars that fill up the spaces.
50. 6171 (H.VI.40). Oph. 1628 *1253*. Globular Cluster. Large but rather pale. Low power. Dist. 69,100 l.y.
51. 6205 (M.13). Hercules. 1638 3636. The "Great Globular Cluster in Hercules." M.13, M.22, and Omega Centauri are the three supreme Globular Clusters in the heavens. M.22 is No. 69 in this list. Omega Cent. is not listed because it is too far south to be seen in San Francisco. M.13 is visible to keen naked eye. Star count in photo has shown 42,000 stars, each of which is much larger than our sun; hence this cluster must contain more than 500,000 stars. Diam. 250 l.y. Dist. 33,600 l.y.
52. 6218 (M.12). Ophiuchus. 1643 *0148*. Globular Cluster of 10-16^{M} stars. Dist. 35,800 l.y.
53. 6254 (M.10). Oph. 1652 *0359*. Bright Globular Cluster. Dist. 36,500 l.y.
54. 6273 (M.19). Oph. 1657 *2609*. Globular Cluster. Appears rather loose and elongated, accentuated by nearby starless spaces like the blackest ink. Dist. 53,000 l.y.
55. 6266 (M.62). Scorpio. 1656 *3003*. Globular Cluster. Quite irregular, but beautiful. Dark space-deeps nearby. Many variables. Dist. 62,600 l.y.
56. 6333 (M.9). Oph. 1714 *1826*. Globular Cluster. Small but clear. A cloud of about 14^{M} stars, just beyond the limits of my telescope to resolve. Dist. 67,700 l.y.
57. 6402 (M.14). Oph. 1733 *0312*. Globular Cluster. Large and interesting. "Like blown star dust." 15-16^{M}. Impossible for small telescopes to distinguish from gaseous. Dist. 64,000 l.y.
58. 6494 (M.23). Oph. 1752 *1901*. Galactic Cluster. "Blazing wilderness of starry jewels." Beautiful low power field. 9-13^{M}. Dist. about 4,500 l.y.
59. 6514 (M.20). Sgr. 1757 *2302*. Gaseous Nebula. The "Trifid," because of three dark rifts laid over it. Curious object on a dark night. My telescope does not reveal the rifts.
60. 6531 (M.21). Sagittarius. 1759 *2230*. Loose Galactic Cluster. Beautiful. Dist. about 2,900 l.y.
61. 6523 (M.8). Sgr. 1758 *2423*. Nebulous Galactic Cluster. Beautiful object resembling the Pleiades, both in visual appearance and in its enmeshment in nebulosity as revealed by long exposure photographs. Naked eye object.
62. 6569 (H.VII.30). Sgr. 1807 *2137*. Compressed Cluster or Star Cloud,—probably the latter. Curious object composed of 10-13^{M} stars. Low power.
63. 6572 (Σ.6). Oph. 1808 0650. A curious, bluish gaseous nebula. "Makes isosceles triangle with two 8^{M} stars."—Barns. W. Struve considers it one of the most curious objects in the sky.
64. 6603 (M.24). Scutum. 1813 *1827*. Giant Galactic Cluster. Sir John Herschel said: "Magnificent to naked eye as a protuberance of the Galaxy." 15^{M} stars and two little pairs. Dist. about 16,300 l.y.
65. 6611 (M.16). Scutum. 1814 *1349*. Galactic Cluster. Nebulous. Dist. about 5,400 l.y.
66. 6613 (M.18). Scutum. 1815 *1710*. Galactic Cluster. Glorious field. One degree south of M.17. Dist. about 6,200 l.y.

67. 6618 (M.17). Scutum. 1816 *1613*. Galactic Cluster. Is known as "The Horseshoe." One degree north of M.18. Very curious. Surrounded by nebulosity which I always think is the object I am seeking. But Shapley lists it as a cluster. Will stand high power. Dist. about 5,400 l.y.
68. 6626 (M.28). Sgr. 1819 *2455*. Globular Cluster of 14-16^{M} stars. Faint. Dist. 54,000 l.y.
69. 6656 (M.22). Sagittarius. 1831 *2403*. Globular Cluster of enormous proportions. "Larger and brighter than M.13 in Hercules though less condensed. 70,000 suns of 10 to 20^{M}."—Barns. The first system determined to be a globular cluster. Dist. 22,100 l.y. Stars seen visually, or in photographs, in globular clusters are all supergiants, or giants, like Antares, Mira, Deneb, and Arcturus. Shapley says: "In only one globular cluster (Messier 22) have stars as faint as the sun been photographed."
70. 6694 (M.26). Scutum. 1840 *0929*. Galactic Cluster. Rather scattered. Dist. about 9,800 l.y.
71. 6705 (M.11). Aquila. 1846 *0622*. Galactic Cluster. Fan shaped with an 8^{M} star near the apex. 11^{M} stars. Called the Shield of Sobieski. Fairly compact. Smyth said it looks like a flight of wild ducks. Shapley suggests that it may not be a cluster at all, but a nucleus of the Scutum Sobieski Star Cloud. Dist. about 4,000 l.y.
72. 6720 (M.57). Lyra. 1851 3256. Planetary Nebula. The famous "Ring Nebula in Lyra." With 270 power the ring becomes a globe of glowing gas lighted by a central star—a condition of all planetaries.
73. 6779 (M.56). Lyra. 1913 3002. Globular Cluster in a fine field. 11-14^{M}. Dist. 66,100 l.y.
74. 6838 (M.71). Sagitta. 1950 1834. Galactic Cluster. Hazy in low power; more interesting in high power. 11-16^{M}. Dist. about 6,500 l.y.
75. 6853 (M.27). Vulpecula. 1956 2230. The "Dumb-Bell Nebula." Two oval gaseous masses in contact which at certain magnifications look like a dumb-bell. 11^{M}.7 star at center.
76. 6981 (M.72). Aquarius. 2048 *1255*. Globular Cluster. In same field as M.73, but slightly west. Many variable stars. Dist. 75,900 l.y.
77. 7009 (H.IV.1). Aquarius. 2059 *1141*. Planetary Nebula. Very large and said to be one of the finest of the planetaries. Has a thin ray on opposite sides. Pale blue. A mass of incandescent gas with a star at the center. Unusual.
78. 7078 (M.15). Pegasus. 2126 1149. Globular Cluster with blazing center. An unusual number of Cepheid variable stars. Dist. about 42,600 l.y.
79. 7089 (M.2). Aquarius. 2129 *0112*. Globular Cluster. A fine condensed mass of stars of about 15^{M}, resembling a large ball. Dist. 45,300 l.y.
80. 7099 (M.30). Capricornus. 2135 *2332*. Globular Cluster. A moderately bright ball of small stars with an 8^{M} star close by. Dist. 47,500 l.y.
81. 6864 (M.75). Sgr. 2201 *2209*. Globular Cluster. Bright. Low power. Dist. 157,000 l.y. and possibly outside of our Galactic System.
82. 7492 (?). Aquarius. 2303 *1610*. Globular Cluster that looks loose and unorganized. Very little concentration at center. Its great distance may account for its unusual appearance. Dist. 82,000 l.y.
83. 7662 (H.IV.18). Andromeda. 2322 4206. Planetary Nebula. Bright, but small. Star at center is bright but becomes obscured by higher power. Two rings and rough edges. Bluish.
84. I have not included the Pleiades (0341 2348, a Galactic Cluster of extreme looseness, enmeshed in nebulosity, probably the most famous assemblage of stars in the heavens; Dist. 489 l.y.) and the Hyades (0414 0523, another extremely loose Galactic Cluster; Dist. 130 l.y.) because they are so well known.

Notes on Celestial Photography

By JOSEPH L. WOODS

It is, of course, well known that photography with the large modern reflectors is the most effective method available for the study of faint celestial objects, but I doubt if the average observer, who has had no personal experience in celestial photography, fully realizes what great advantages it offers with even the most modest equipment.

One of my earliest successful pictures was the result of an exposure of an hour and a half on the Great Nebula in Andromeda with an anastigmat lens of 3½ inches aperture and 16 inches focus. I had often observed this object with a small refractor and I had read what astronomers of the last century had to say about its appearance. I had learned that its spiral structure was not definitely revealed until the advent of photography and I had seen and admired the beautiful photographs that had been made of it with great reflecting telescopes, but I did not dare to hope that my little lens would do more than show its shape and its position among the stars. When I developed the plate, I was as much surprised as I was pleased to find an image of the nebula that clearly showed its spiral form.

Most of the spiral nebulae appear so small that this lens will not show them in any detail, but I got recognizable pictures of many of the galactic nebulae such as the well-known Orion nebula, the filimentary nebulae in Cygnus, and the large dim North America nebula, also in Cygnus. On one plate that included the greater part of the constellation of Orion, I found not only a presentable picture of the Orion nebula, but also the group of small nebulae just east of the star at the eastern end of the belt. It was even possible to see a faint image of the "Horse-head" nebula.

Near the zenith, on a fine night, this lens will record stars as faint as magnitude 13.5 in an hour's exposure. Small scale, wide angle photographs of this type offer a very effective means of discovering novae, asteroids, and variable stars. Even a small hand camera, designed for terrestrial use, will not only reveal objects so faint as to be far beyond the reach of the naked eye, but will also perform surprising feats of resolution. During the Leonid meteor shower in the fall of 1933, I attached a small Graflex camera, with a lens of less than 6 inches focus, to the tube of a clock-driven telescope and kept the shutter open for two hours in the hope of photographing meteors. No meteors appeared but it so happened that the "Bee-hive" cluster in Cancer was in the field, and on the plate it was completely resolved although the whole cluster was only 3/32 inch in diameter.

A lens of 7 3/16 inches focus will make photographs on the same scale as the maps in Norton's Star Atlas, and enlarged prints from such photographs make the best charts obtainable as an aid in finding faint objects and those that are hard to recognize, such as asteroids and the

fields of unfamiliar variable stars. If the photograph was exposed long enough, everything that can be seen in the telescope will appear on the print, and the observer need only identify the field to which his telescope happens to point and then work his way, star by star, to the desired region.

A good photograph is authoritative. It often happens that, while looking at a familiar field, the observer will see a star that he does not remember ever having seen before. If he is impetuous and optimistic, he will assume that it is a nova or, at least, an asteroid. If he has a photograph of the region, taken previously, he will be able to settle the matter immediately, and will usually find that the star in question has been there all the time. If, on the other hand, the star does not appear on the photograph he may be assured that he has found something new. A photographic print may, and often does, have blemishes that look, at first glance, like star images, but I have never known a photograph to commit any sin of omission. Each star or other object within the field will, if it is bright enough, leave its record on the plate.

If, instead of using a small camera lens, we photograph with the objective (lens or mirror) of the telescope, we will get pictures on a different scale. The image will be much larger and the angular width of the field will be greatly reduced. If the telescope is a reflector of the usual design, the field of good definition is a circle not much over one degree in diameter. The field of the photograph may perhaps be increased to two degrees if we do not mind elongated star images around the edge.

Whatever lens or mirror is used, the size of the image is in direct proportion to the focal length. Thus, if two stars appear 1/32 inch apart on a negative made with a camera lens of 6 inches focus, they will be separated by ten times this distance, or nearly 1/3 inch, when photographed with an objective of 60 inches focus. The star images themselves will not be any larger. According to the Dawes rule, an objective will form a star image the angular diameter of which equals 4″.5 divided by the aperture of the objective in inches. By this formula, a 9-inch mirror should produce star images having an angular diameter of 0″.5, while an 18-inch mirror would bring them down to half this angle. If the focal ratio of the two mirrors is the same, the larger will have twice the focal length and will, in consequence, magnify twice as much as the smaller and will form, on the plate, star images of the same linear diameter as those formed by the 9-inch glass. From this, it may be seen that a mirror of very short focus would, theoretically, yield images of smaller linear diameter than would another of the same aperture but with a focus of normal length. The experience of visual observers, under the best atmospheric conditions, has conformed very closely with the Dawes rule, but the photographer cannot do nearly so well. In even the best of "seeing," there are moments when the image becomes blurred and it is shifted about by an almost continual small undulation that is not very

noticeable to the visual observer, but does great harm to a photograph. The images on the plate are disturbed during the exposure not only by atmospheric irregularities but also by perturbations of the telescope itself. The slightest tremor in the instrument will shift the negative by an amount far greater than the diameter of the focal image of a star. These various displacements of the plate and image with relation to each other result in a general blurring. Each star is represented not as it should be, as a very minute clean-cut point, but as a spot of considerable size, dense at the center and fading off toward the border.

As stated above, a 9-inch mirror will form a star image ½ second of arc in diameter. If its focal length is 60 inches, this ideal image on the photographic plate will have a linear diameter of .00014 inch. The photographer will have done extremely well if the faintest images that appear on the developed plate are ten times this large. The smallest I have been able to get with a fine 12-inch mirror are about .003 inch.

It is needless to say that bad guiding can do more damage than all these other sources of troubles combined. Bad guiding, however, is usually in right ascension rather than declination and will result in images that are elongated rather than enlarged in all directions.

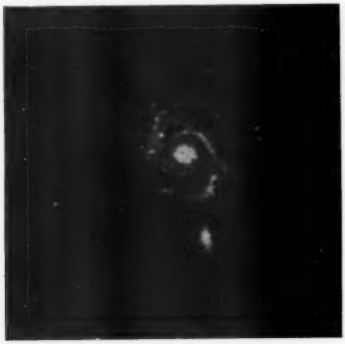
In view of the foregoing, it would seem that, for exposures of any length, there is no need for optical equipment of the very highest degree of perfection, as its good qualities must necessarily be obscured to some extent by unavoidable difficulties of an atmospheric or mechanical nature. I think it very probable that many home-made mirrors that do not quite measure up to the most exacting standards, could be made to produce photographs that would compare favorably with those made with standard equipment of corresponding size.

In general, photography is best suited for the study of objects that do not require high magnification. Under good observing conditions, a 10- or 12-inch glass, used visually, will show finer planetary detail, and resolve close double stars better than will even the largest telescopes when used photographically.

Photography is at its best in recording faint objects. It has revealed almost countless stars and nebulae that cannot be seen at all at the eyepiece of any existing telescope, and it has shown us the detailed structure of many nebulae that are seen imperfectly and with great difficulty by direct observation. The large spiral nebula, M 101, in Ursa Major, is such a faint and uninteresting object for visual observing that the Rev. T. W. Webb did not think it worth including in his "Celestial Objects for Common Telescopes," and Lord Rosse, with his 72-inch reflector, did not note its spiral shape although he saw, and listed separately, several condensed masses in its outlying portions. A two-hour exposure on this nebula, with a 12-inch mirror, shows it as one of the most pleasing objects of its kind and leaves no doubt whatever as to its spiral structure.

It very often happens that a comparatively short exposure with a

small telescope will show some of the brighter details of a nebula very plainly whereas, in long exposures with a large aperture, they are obscured by the over-exposure of the fainter material in the background. The photograph of M 51 in Canes Venatici, illustrated here, is a good example of this. In this picture (made in two hours with a 12-inch reflector) the very sharp double bend in one of the two main spiral arms



(Photograph by Woods and Watson)
FIGURE 1
M 51, IN CANIS VENATICI

shows quite plainly while in a well-known photograph, exposed much longer with one of the very large reflectors, this bit of detail is quite inconspicuous.

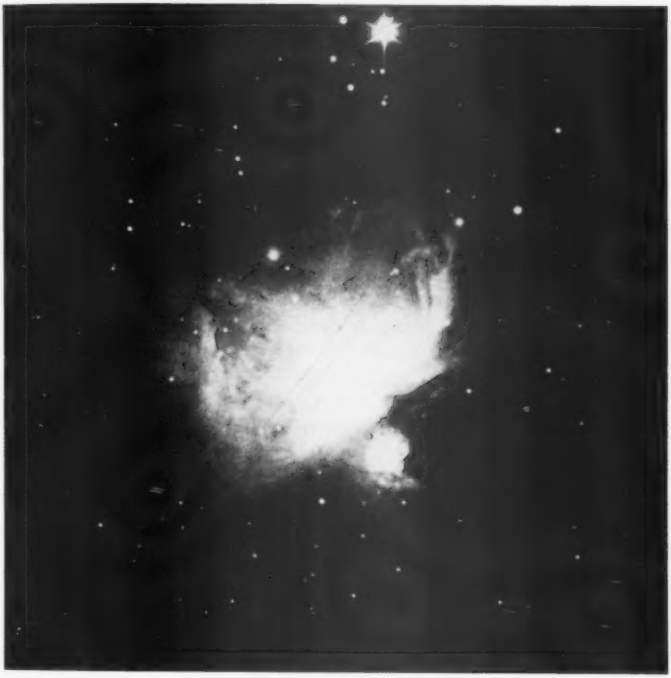
It must be remembered that any photograph loses much not only in reproductions but also in printing from the negative. When the latter is viewed against a strong light, detail can usually be seen in the dense portion of the image that cannot be brought out in the print.

The Orion nebula is very rich in actinic light. The photograph reproduced here was exposed for only half an hour, yet the central part is so over-exposed that it does not represent at all what we see when we look at the object in the telescope. In the negative, the trapezium and other details can be seen with difficulty in the densest part of the image.

The amateur celestial photographer will do well to choose his subject with due regard to the nature of his equipment. If he has a lens of short focus and wide angle, he may make photographic charts or beautiful pictures of the star clouds and larger nebulae in the Milky Way. If he is to use a reflecting telescope, he must confine himself to detailed views of small areas. There are nebulae in a wide range of sizes from the Great Nebula in Andromeda, which is about two degrees in length, down to minute objects that require the largest telescopes to distinguish them from stars. Star clusters, too, vary greatly as to size and density, and it is best to select those that can be resolved by the instrument in question. My 12-inch mirror will completely resolve fairly compact clus-

ters such as M 37 in Auriga, M 11 in Scutum, and M 4 in Scorpio, but it fails to resolve the dense central part of the great globular cluster in Hercules. Most of the globular clusters are fit subjects for only the largest telescopes guided by the most skillful hands.

The systematic photographing of an active variable star is very interesting work and the results are, in some cases, more accurate than can be obtained from visual estimates. It often happens that a variable is so close to another star that the two seem to merge together when the ob-



(Photograph by Woods and Watson)
FIGURE 2
THE ORION NEBULA

server's eye is directed to a comparison star a little distance away. There is a field in Draco in which there are two variables (T and UY Draconis) that are only about 20″ apart. Photographs of such objects can usually be measured to a tenth of a magnitude by inspection, without the use of a microphotometer. For this sort of work it is well to use a yellow-sensitive plate with a yellow filter so that the results will be comparable with visual magnitudes. Exposures made in this way, on an average star field, must be about three times as long as those made with an

ordinary plate and no filter. I have found that I can be reasonably sure of reaching 14th magnitude in one hour with a Cramer Iso Presto plate and a Wratten G filter, used on a 12-inch reflector with aluminized mirrors. For each magnitude fainter, the exposure must be multiplied by three. Thus, it would take the 12-inch 3 hours to reach 15th magnitude, while stars of the 13th magnitude could be photographed in 20 minutes.

For photographing star images, the length of exposure varies in inverse proportion to the square of the aperture of the objective, so the necessary exposure for any given star may be roughly determined, for any size telescope, from very meagre data. It could be determined quite accurately except for some little variation in the sensitivity of our photographic plates and a very great variation in the transparency of the atmosphere.

The Richest-Field Telescope

By S. L. WALKDEN

A time when discoveries with large telescopes overshadow much that can be done with small ones would seem to be the time when anything in which small telescopes excel should be rescued from oversight. Now there is one curious and pleasing thing in which small telescopes of about 3 inches aperture do excel, and that—surprising to many who first hear of it—is in being able to show *more* stars in the average Milky Way view than any smaller or *larger* telescope can show.

In one way of explaining this, suppose we make a telescope to reveal stars down to a certain magnitude m, and therefore one to be called an mth-magnitude telescope. Using as symbols—

A for the apparent average star-density in the eyepiece, or number of stars per apparent square degree of area of the field of view,

Δ for the actual average star-density in the sky down to the magnitude m, that is for the number of stars down to magnitude m per square degree of area of the actual sky, and

M for the magnifying power;

then it should be evident enough that

$$A = \Delta/M^2; \tag{1}$$

on which account we could make the field look as crowded as we liked, by using a lower and lower magnifying power, if it were not for an important limit now to be explained with the aid of three further symbols—

a for the aperture diameter in inches, which the observer needs and uses to see clearly the mth-magnitude stars,

d for the inches diameter of the Ramsden circle or exit pupil, through which the light of the object glass emerges from the eyepiece, and

e for the inches diameter of the pupil of the observer's eye in the dark.

With any telescope it is an inevitable optical rule that $d = a/M$, so

that as M is lessened d enlarges. But directly d commences to exceed e, as it must do when M is less than a/e, some of the light of the telescope fails to enter the eye. That makes the faint stars of actual magnitude m disappear, and therefore makes the mth-magnitude telescope cease to exist. Therefore, substituting a/e for the lowest and richest M in (1), we have for the mth-magnitude telescope—

$$\text{Utmost } A = e^2 \times (\Delta/a^2) \tag{2}$$

Using as a further symbol—

k for the inches aperture diameter with which the observer sees 9th-magnitude stars,

we know that, because stars are 2.512 times fainter per magnitude,

$$a^2 = k^2 \times 2.512^{m-9} \tag{3}$$

and substituting this for a^2 in (2), we have for the mth-magnitude telescope—

$$\text{Utmost } A = (e^2/k^2) \times (\Delta/2.512^{m-9}) \tag{4}$$

Therefore, because e^2/k^2 is a constant, Utmost A increases for increasing magnitude telescopes, so long as Δ increases faster than 2.512^{m-9} increases with increase in m; and it reaches its maximum at that magnitude of star and telescope where Δ ceases to increase at a faster rate than the 2.512 times per one step in magnitude at which the 2.512^{m-9} continually increases.

According to good tables of star-density, like the Chapman & Melotte tables for the zone of the Milky Way, Δ ceases to increase faster than 2.512 times per step in magnitude just at the 11th-magnitude stars. Therefore the 11th-magnitude telescope exhibits the maximum Utmost A, and therefore it is the Richest-Field *Size* of Telescope. For very keen-sighted observers k is as small as 1.00 inch, in which case, from (3), $a = \sqrt{(1.00^2 \times 2.512^{11-9})} = 2.512$ inches, or say 2.5 to 3 inches aperture for ordinary observers. For an observer with an eye pupil with e as great as 0.30 inches in the dark, the Richest-Field magnifying power with this telescope, or a/e, is then as low as 2.512/0.30, or 8.4. Then, by (4), Utmost $A = (0.30^2/1.00^2) \times (\Delta/2.512^{11-9}) = 0.01426 \times \Delta$; and Δ being 25.40 for the 11th-magnitude stars according to good star-density tables, this observer's Maximum Utmost $A = 0.3622$, meaning 362 stars visible per 1000 square degrees of the apparent field of view. Of course with a modern eyepiece field appearing 50 degrees in diameter, and so of $50 \times 50 \times 0.7854$, or 1964 square degrees area, the number of stars in the average Milky Way view can be as high as 711.

The conclusion that the Richest-Field Telescope is of the size corresponding to the magnitude of stars where the stars increase in numbers just as fast as they decrease in brightness, holds firm; but too much precision and other things should not be read into the further conclusions. Tables of star-density still differ as to the exact magnitude at which the stars increase in number 2.512 times per step in magnitude,

some tables placing it nearer the 13th than the 11th magnitude. That would make the Richest-Field size of telescope nearer 7 inches than 3 inches, with a Richest-Field magnifying power of about 24. Then it needs considering, that while the Utmost Apparent Star-density declines rather gradually in the views with the larger telescopes, the proportion of strikingly bright-looking stars increases rather rapidly and the proportion of faint-looking ones decreases rather rapidly; so that except in actual number of stars to be counted, the fields of the larger telescopes generally *look* richer, and decidedly more splendid.

It is not easy to arrange an ordinary long-focus 2.5- to 3-inch astronomical telescope as The Richest-Field Telescope, because of the large size of the 9- to 10-power eyepiece needed; but it is easy enough when an object glass of focal length only about 5 to 6 times the aperture is employed. Several of the best optical manufacturers of the world are already listing small, low-powered, short-focus telescopes which are practically Richest-Field Telescopes; and with them most beautiful views may be obtained of the star clouds of the Milky Way, especially of those star clouds near the constellations of Cygnus in the north and Scorpio in the south.

One other formula for Utmost A may be given in conclusion. Calling the 9th-magnitude star just visible with k^2 area of aperture the star of unit brightness or illumination, and using—

> i for the brightness or illumination of the star just perceptible with aperture area a^2, then evidently—

$$a^2/k^2 = 1.00/i, \text{ or } a^2 = k^2/i, \tag{5}$$

which inserted for a^2 in (2) renders us for the mth-magnitude telescope

$$\text{Utmost } A = (e^2/k^2) \times \Delta \times i \tag{6}$$

This (6) corresponds to (4), for i is the same as $1/2.512^{m-9}$; but (6) is a form that avoids the magnitude convention, and therefore in some opinion makes it plainer how the Maximum Utmost Apparent Star-density, A, for the Richest-Field Telescope occurs for the stars and telescope corresponding to where Δ, the star number, ceases to increase faster than i, the star's brightness, decreases; or, in other words, where the stars down to one per cent fainter are precisely one per cent more numerous.

46 Cavendish Road, London N4, England.

Planet Notes for April, 1936

By CLIFFORD E. SMITH

Note: All times, unless otherwise stated, are Central Standard Time.

The *Sun* will be moving with an apparent northeasterly motion from the central part of Pisces to the central part of Aries. Its distance from the earth will increase from about 92.9 to about 93.6 million miles. The position of the sun on the first and last days of the month will be, respectively: R.A. $0^h\,41^m$, Decl. $+4°\,24'$, and R.A. $2^h\,28^m$, Decl. $+14°\,39'$.

The phenomena of the *Moon* will occur as follows:

Full Moon	April	6 at	5 P.M.
Last Quarter		14 "	3 P.M.
New Moon		21 "	7 A.M.
First Quarter		28 "	5 A.M.
Apogee		5 "	MIDNIGHT
Perigee		20 "	2 P.M.

Mercury will be moving with an apparent easterly motion from the central part of Pisces, across Aries, to western Taurus. At the beginning of the month it will be near the sun in the morning sky. On April 10 at 7:00 A.M., superior conjunction with respect to the sun will occur. Toward the end of the month Mercury will be an evening object setting about an hour after the sun. Its distance from the earth will decrease from about 124 to about 95 million miles. The corresponding change in apparent diameter will be from about 5.0 to about 6.6 seconds of arc. On April 19 at 3:00 P.M., Mercury will be at its perihelion point. Conjunction with Uranus will occur on April 17 at 9:00 A.M. (Mercury 56′ N), conjunction with Mars will occur on April 22 at 10:00 A.M. (Mercury 1°.3 N), and conjunction with the Moon will occur on April 22 at 6:00 A.M. (Mercury 2°.7 S). The position of Mercury on the first and last days of the month will be as follows: R.A. $0^h\,8^m$, Decl. $-1°\,11'$, and R.A. $3^h\,42^m$, Decl. $+22°\,3'$.

Venus will be a morning object rising about an hour before the sun. It will be moving with an apparent easterly motion from eastern Aquarius to eastern Pisces. At the beginning of the month its distance from the earth will be about 140 million miles, and this distance will increase about 10 million miles during the month. The corresponding change in apparent diameter will be from about 11.0 to about 10.3 seconds of arc. Conjunction with the moon will occur on April 20 at 4:00 A.M. (Venus 7°.1 S).

Mars will be an evening object rather near the sun in apparent position. Toward the end of the month it will set about a half hour after the sun. Its apparent motion in the sky will be from western to eastern Aries. Its distance from the earth will be about 225 million miles and its apparent diameter will be about 4 seconds of arc. Conjunction with Uranus will occur on April 7 at 10:00 P.M. (Mars 25′ N), conjunction with Mercury will occur on April 22 at 10:00 A.M. (Mars 1°.3 S), and conjunction with the moon will occur on April 22 at 6:00 A.M. (Mars 3°.9 S).

Jupiter will be a morning object in southeastern Ophiuchus. Its apparent motion among the stars will be direct (easterly) until the 10th of the month when it will become retrograde (westerly). During the middle of the month it will rise about an hour before midnight for northern observers; somewhat earlier for southern observers. Its distance from the earth will be about 440 million miles

and its apparent diameter will be about 39 seconds of arc. On April 12 at 7:00 A.M., it will be in conjunction with the moon (Jupiter 1°.6 N).

Saturn will be a morning object in northeastern Aquarius and during the middle of the month will rise about two hours before the sun. Its distance from the earth will be about 970 million miles and its apparent diameter will be about 14 seconds of arc. Its apparent motion among the stars will be direct (easterly). On April 18 at 3:00 P.M. it will be in conjunction with the moon (Saturn 7°.2 S).

Uranus will be near the sun in apparent position in southwestern Aries. At the beginning of the month it will set somewhat more than an hour after the sun, when it will rapidly approach the sun until the occurrence of conjunction on April 25 at 4:00 P.M. Its distance from the earth will be about 1930 million miles and its apparent diameter will be about 3.3 seconds of arc. Uranus will be in conjunction with three different objects: on April 7 at 10:00 P.M., with Mars (Uranus 25′ S), on April 17 at 9:00 A.M. with Mercury (Uranus 56′ S), and on April 21 at 4:00 P.M. with the moon (Uranus 5°.0 S). Its position on April 15 will be: R.A. $2^h\ 11^m$, Decl. +12° 43′.

Neptune will continue as an evening object in southeastern Leo about a degree southeast of χ Leonis. It will be on the meridian, that is, toward the south about 9:30 P.M., local standard time, during the middle of the month. Its distance from the earth will be about 2740 million miles and its apparent diameter will be about 2.5 seconds of arc. Its apparent motion among the stars will be retrograde (westerly). Conjunction with the moon will occur on April 4 at 4:00 A.M. (Neptune 6°.2 N). The position of Neptune on the 15th of the month will be: R.A. $11^h\ 4^m$, Decl. +7° 6′.

Note: For help in judging distances between objects at conjunction, it is to be remembered that the apparent diameter of the moon is about half a degree (30 minutes of arc).

OCCULTATION PREDICTIONS

(Taken from the *American Ephemeris.*)

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′.

Date 1936		Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
				h m	m	m	°	h m	m	m	°
April	9	17 G.Lib	6.4	5 24.7	—0.6	—1.6	162	6 22.1	—2.8	+0.8	245
	9	18 G.Lib	6.1	6 27.8	..	..	183	6 56.4	..	..	221
	10	42 Lib	5.1	7 8.2	—1.8	—0.9	134	8 24.3	—2.2	—0.2	252
	11	22 Sco	4.9	4 57.2	—0.5	—0.2	141	5 59.7	—2.1	+1.5	246
	18	6 G.Psc	6.2	8 31.9	—0.2	+2.0	41	9 25.3	—0.5	+1.3	268
	27	61 Gem	5.9	0 38.2	—1.5	—0.8	82	1 38.6	—0.2	—2.6	323

Occultations Visible in Longitude +91° 0′, Latitude +40° 0′.													
April	4	β^2	Leo	6.2	8	52.6	−0.4	−2.2	142	9	50.5	−0.2	−1.5	272
	10	169	B.Lib	5.8	4	56.3	..	..	41	5	22.0	..	..	0
	10	42	Lib	5.1	6	50.2	..	..	168	7	34.6	..	..	230
	13	24	Sgr	5.7	12	22.7	−2.1	−0.8	98	13	36.3	−0.9	+0.1	228
	14	50	Sgr	5.6	10	12.5	−2.0	+0.8	92	11	33.0	−1.8	+0.9	235
	16	53	B.Aqr	6.5	10	54.3	−1.2	+2.2	31	11	58.9	−2.0	+0.5	278
	27	61	Gem	5.9	0	10.8	−1.6	−1.4	116	1	30.6	−1.4	−1.7	290
	29	222	B.Cnc	6.3	6	6.4	−0.5	−1.0	74	6	50.7	+0.4	−2.3	337
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′.													
April	4	β^2	Leo	6.2	8	53.5	..	..	187	9	28.1	..	..	242
	5	13	B.Vir	5.8	11	11.1	−0.7	−2.0	130	12	16.4	−0.3	−1.6	282
	13	24	Sgr	5.7	11	17.3	−2.1	+0.8	89	12	46.3	−2.3	+0.6	253
	14	50	Sgr	5.6	9	32.5	−0.6	+0.6	113	10	34.2	−1.5	+2.0	231
	14	253	B.Sgr	6.0	12	18.9	−2.0	+1.6	54	13	42.8	−2.4	+0.1	271
	16	53	B.Aqr	6.5	10	18.9	−0.6	+2.2	41	11	13.6	−0.7	+0.9	282
	25	121	Tau	5.3	2	42.3	−1.1	−1.0	90	3	47.2	−0.4	−1.8	293
	29	222	B.Cnc	6.3	5	48.6	−1.0	−1.8	117	6	59.4	−0.5	−2.1	305

Comet Notes

By G. VAN BIESBROECK

Amateurs have no opportunity to observe known comets at this time. Only with powerful instruments can two faint objects be followed, both losing in brightness. These are Periodic Comets 1927 III (Comas Solá) and 1929 I (Schwassmann-Wachmann). The first one has been followed since last summer in its first return since discovery. It had dropped to 15^M on February 18 but still showed a faint little tail in a direction opposite to that of the sun. The second one, also in its first return since discovery, has been followed since December, 1934, but with a long interruption during the summer of 1935 when it was in conjunction with the sun. It became visible again last November and is now well placed for observation, but on February 18 it had become hardly as bright as a 16^M star. Both objects are receding and will soon be lost on account of extreme faintness.

In March we may expect the first observations of Comet 1935 *d* (Van Biesbroeck) after its conjunction with the sun. The latest observation on this object was obtained by the writer on December 21. It showed the following correction for Maxwell's orbit mentioned in the November number (p. 606): +12^s and +1′.3. In order to have a closer prediction for this year's apparition, advantage was taken of the prediscovery position obtained from plates exposed at Johannesburg in July so as to cover an arc of 170 days. I used the following three positions for determining a new orbit:

		α (h m s)	δ (° ′ ″)	
1935 July	3.89639	20 24 48.81	−22 18 25.8	Johannesburg
Sept.	28.08655	19 24 3.59	−13 17 53.7	Yerkes
Dec.	21.00887	19 58 27.06	− 4 5 8.9	Yerkes (mean of 2)

The result was as follows:

T = 1936 May 12.21366 U.T.
q = 4.039338
e = 1.003525

Ω =	299°.65178		299°.66569
i =	66.10214	1935	66.10222 1936
ω =	45.03700		45.03688

A parabolic solution fitting the first and last positions cannot be made to represent the middle one within less than 30″. Hence the slightly hyperbolic solution which gives the ephemeris:

1936		α h m s	δ ° ′	Distance from Sun	Distance from Earth
Mar.	13	21 8 36	11 3.3	4.07	4.81
	17	21 11 43	12 1.2	4.07	4.77
	21	21 14 45	13 0.5	4.06	4.73
	25	21 17 42	14 1.3	4.06	4.70
Mar.	29	21 20 34	15 3.4	4.06	4.66
Apr.	2	21 23 20	16 6.9	4.05	4.61
	6	21 25 59	17 11.7	4.05	4.57
	10	21 28 31	18 17.9	4.05	4.53
	14	21 30 56	19 25.4	4.05	4.49
	18	21 33 14	20 34.2	4.04	4.44
	22	21 35 22	21 44.3	4.04	4.40
	26	21 37 21	22 55.5	4.04	4.35
Apr.	30	21 39 10	24 7.9	4.04	4.31
May	4	21 40 49	25 21.3	4.04	4.26

This should be more accurate than the values given by Maxwell (*loc. cit.* p. 607). The comet will be a morning object, quite faint at first but it is expected to brighten up somewhat while the geometric conditions of visibility improve .However, even at perihelion this very distant object will remain faint.

Williams Bay, Wisconsin, February 20, 1936.

METEORS AND METEORITES

The Meteor of September 16, 1929

By C. C. WYLIE

This meteor fell at about 8:15 P.M., 90th meridian time, on the evening of September 16, 1929. It was reported to us by several observers in eastern Iowa and northern Wisconsin, and by one observer as far away as Elk Point, South Dakota. Two observers were interviewed in Iowa City, Iowa, by the writer; one observer was interviewed in Dubuque, Iowa, by Father J. A. Theobald of Columbia College; and one was interviewed in Burlington, Iowa, by Mr. William Davidson who had recently completed a course in Descriptive Astronomy at the University of Iowa. These were the only interviews made according to our instructions by persons with training in astronomy. Additional information on this meteor was, however, received from Professor S. W. Hockett of Penn College, Oskaloosa, Iowa, from Dr. Mark L. Floyd of the University of Iowa, and from other persons who had either seen the meteor personally or had interviewed observers of the meteor.

The number of interviews on this meteor is much less than for most meteors on which we have published results. The small amount of material is the reason that the path of this meteor was not published at an earlier date. Recently, however, in looking over the material on a number of meteors, we noticed that the velocity of this meteor was quite high for one observed in the early evening. It appeared that we did have some interviews giving information on all the essential points. We have, therefore, computed the path, radiant, and velocity.

The light of this meteor was such that many compared it to a rocket leaving a train of sparks. The meteor was not, however, bright enough to cast shadows

or to light the sky noticeably. Its light must have been less than that of the moon at quarter; but from the number of letters received, its light must have been much more than that of Venus.

The adopted longitude and latitude of the bursting point depend chiefly on the Iowa City and Dubuque interviews. The adopted height for bursting depends on measures at Iowa City and Burlington, and on the observation at Oskaloosa. The adopted bursting point is longitude 91° 28′.2 and latitude 43° 6′.8. This is a point about 11 miles south of Waukon, Iowa. The height of bursting was found to be 40 miles.

The adopted longitude and latitude for the point of appearance depend on one measure from Iowa City and one measure from Dubuque. These were the only measures available, and the mean of the two was adopted. As this meteor did not light up the landscape noticeably, perhaps we should not assume that the point of appearance was the same for all observers, but probably the best we can do is to assume that for most observers the point of appearance was approximately the mean of the two measures available. The adopted longitude of appearance is 90° 17′.9 and the latitude is 43° 49′.9. This is a point about 10 miles west and three miles north of Mauston, Wisconsin. The height of appearance was 107 miles. The projected length of path was 77 miles, and the real length of path was 102 miles.

For determining the radiant, the measured slopes from Dubuque, Iowa City, and Burlington were used. The estimated slope received from Oskaloosa, Iowa, and another estimated slope received from Shullsburg, Wisconsin, were also used but given less weight. The coördinates of the radiant were found to be azimuth 230° from the south point and altitude 40°.

Three values for the duration of the meteor were used. At Iowa City, a lady who was driving her car noted where she was when the meteor was first seen and where she was when it disappeared behind a house. A day or two later she drove her car down the street twice, attempting to reproduce the speed at which she was driving when the meteor fell. She was travelling at just about 20 miles per hour. The distance travelled by the car in the interval was measured giving 1.7 seconds as the duration. From the height of the house we calculated the amount of the path probably lost, and estimated that the duration for the complete path was about 2 seconds. At Dubuque, Father Theobald had a lady attempt to reproduce the remarks made as the meteor fell. From this reenaction of the events, he obtained, "3 seconds or possibly more," as the duration. At Shullsburg, Wisconsin, a man with considerable experience in the use of stop-watches estimated the duration. His figure was 2.5 to 3 seconds. The value of 2 seconds obtained from the motion of the car was considered the most impersonal and, therefore, given double weight. For Dubuque, the value 3.25 seconds was adopted as representing 3 seconds or possibly more. For the Shullsburg estimate of 2.5 to 3 seconds we adopted 2.75 seconds. From these values the weighted mean for the duration of the meteor was found to be 2.5 seconds.

From the length of path, 102 miles, and the duration, 2.5 seconds, the apparent velocity of the meteor was found to be 40.8 miles per second. This gives for the heliocentric velocity 34.2 miles per second. The correction has been applied for zenith attraction but not for diurnal aberration.

The height in miles for both appearance and disappearance is greater than for most meteors and the heliocentric velocity is above the parabolic, suggesting that the meteor, before its fall, was not a member of the solar system. We believe that

the height for bursting is not greatly in error. The observers had reasonably good landmarks, and the measures were in fair agreement. The height of appearance is, however, not well fixed. We had only two measures on this, and the landmarks were not good for either. Further, the two measures were somewhat discordant. From experience we know that where there are not good landmarks, there is a tendency to make the path too long. It is possible, therefore, that the height given for appearance is too high, and that the length of path is too long. If this is true, the velocity is too high.

The results obtained for this meteor are summarized in the following table.

SUMMARY

Time	8:15 P.M., Sept. 16, 1929
Longitude of appearance	90° 17′9
Latitude of appearance	43° 49′9
Height of appearance	107 miles
Longitude of bursting	91° 28′2
Latitude of bursting	43° 6′8
Height of bursting	40 miles
Length of path	102 miles
Projected length of path	77 miles
Altitude of radiant	40°
Azimuth from south, of radiant	230°
R.A. of corrected radiant	15° 37′5
Decl. of corrected radiant	+52° 53′5
Apparent velocity	40.8 miles/sec
Geocentric velocity	40.2 miles/sec
Heliocentric velocity	34.2 miles/sec

University of Iowa, February 21, 1936.

Fireball Seen in Duluth, Minnesota, and Vicinity

By J. H. DARLING

People in northern Minnesota were treated to a thrilling exhibition of heavenly fireworks in the early evening of Sunday, December 1, 1935, when a brilliant meteor flashed across the sky, lighting up the country and finally bursting into pieces. It was not my privilege to see this object, but I received a number of reports by telephone and letter and some sketches, with more or less detail of the phenomenon.

It occurred about 7:55 P.M., Central Time. This was after dark, and the sky was clear at Duluth. At that early hour of the evening there would naturally be quite a number of people out of doors on streets and highways who would see the meteor. Eight messages came from various points in Duluth, and five reports from outside towns, namely: from Aurora and Virginia in St. Louis County, from Trail and Lengby in Polk County, and from Ino, Wisconsin, 14 miles west of Ashland. Professor C. C. Wylie writes that he has reports on the same meteor from Iowa City, Iowa, and from Webster City, Iowa.

As to the path of this meteor the observations at hand permit only a very rough approximation. It apparently passed over the Minnesota counties of Lake, St. Louis, Beltrami, and Polk, in a general westerly direction, but somewhat south of due west; crossing the meridian north of the zenith at Aurora and Virginia and Lengby, and south of the zenith at Trail. The meteor burst somewhere farther west, with an intensified flash of light.

More observations are needed for a definite determination of the meteor's path. No doubt more could have been obtained by a careful search, as has been

done so successfully by Professor Wylie and others in cases of several meteors in recent years as reported in POPULAR ASTRONOMY. I regret that I could not undertake such an investigation.

Other fine meteors have been reported by people in Duluth and vicinity on several occasions in past years, but I was unable to obtain much definite information regarding them. Meteors appear so suddenly and vanish so quickly that comparatively few persons observe them. In all my long life of 88 years it has never been my good fortune to see a fine meteor of fireball. This is to my regret for I know I have missed some of the grandest celestial spectacles that are afforded to earthly inhabitants. It seems quite fitting too that the meteor, a visitor from distant space, should come to us invested with such impressive pomp and splendor.

Duluth, Minnesota, January 30, 1936.

Contributions from the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD, President, *and* H. H. NININGER, Secretary

A New Chemical Analysis of the Staunton, Virginia, Siderite

By RICHARD E. LAUTERBACH

A new quantitative analysis of the Staunton, Virginia, siderite (found 1858-9) has recently been made in the chemical laboratories of the University of California at Los Angeles, with the intention of gaining experience in the analytical procedures involved, and of checking the results obtained with those of earlier determinations, so that an analysis of some hitherto unanalyzed specimen might in future be undertaken with confidence. The sample employed consisted of about sixty grams of thoroughly oxidized shavings, purchased in 1931 from Ward's Natural Science Establishment, Rochester, New York. This material was not pulverized, since no adequate machine was available for the purpose.

The results of the analysis follow:

Element	*Percentage*
	%
Fe	89.81
Ni	8.41
Co	0.82
P	0.21
Sn	0.17
C	0.08
Si	0.03
S	0.02
Cl	trace
Mn	trace
	%
Total	99.55

This analysis does not check very closely with any of the six analyses of the Staunton meteorites previously published.[1] The fact is not surprising, inasmuch as the shavings may all have come from one part of a single meteorite; in this event, their composition would not necessarily be identical with that of another portion of it, or with the average composition of the entire specimen. The differ-

[1] Farrington, O. C.: *Meteorites of North America, Mem. Nat. Acad. Sci.*, **13**, 423-9, 1915.

ence between the total percentage obtained (99%.55) and one hundred per cent is ascribable probably to the oxidized state of the material.

The writer wishes to thank Dr. Frederick C. Leonard, Chairman of the Department of Astronomy of the University of California at Los Angeles, for proposing this problem, and for supplying, from his collection of meteorites, the material used in the analysis, and Dr. William R. Crowell, of the Department of Chemistry, for helpful advice regarding some of the analytical methods.

Department of Astronomy, University of California at Los Angeles, January, 1936.

Meteorite Falls in 1933—Four Recent Large Meteors

By H. H. NININGER

The writer has previously pointed to evidence that 1933 was a year favorable for the arrival of meteorites on the earth.[1] The recovery of four falls occurring within the United States in the course of that year was thought to be significant. Now comes the report that three falls occurred in the same year within the U.S.S.R. Reports have not yet arrived from other parts of the world, but they doubtless will in time. It is interesting to note that in the 132 years since man began recording these cosmic events, only nine calendar years have to their credit as many falls (throughout the entire world) as has 1933 in these two countries alone. One year only may boast of a record above seven; this was 1868, which is credited with nine recovered falls. The Society for Research on Meteorites looks forward to the receipt of other reports from workers in various parts of the world.

Another unusual fact regarding the falls of 1933 was the arrival of two meteorites on the same day—a siderite of 7 kgs., at Repeev Khutor, in the lower Volga district, Russia, and a small shower of aërolites in Sioux County, Nebraska —both on August 8, 1933! Roughly only 500 falls have been registered in a period of about 48,300 days, since the recording of meteorite falls began. This is an average of about one fall in 96 days. In view of this infrequency, it is remarkable that two falls should occur on the same day. Both of these falls were of unusual varieties of meteorites, the siderite being about the twenty-fifth all-metal meteorite on record as an observed fall, and the Sioux County stones belonging to the Howardite group, of which there have been recorded scarcely more than a dozen.

On November 24, 1935, residents of southern Missouri and northern Arkansas were disturbed by the passage of a large fireball which produced earth tremors in the vicinity of West Plains and several neighboring villages. Again on January 10, 1936, before dusk, the same area was treated to the sight of an even more spectacular meteor, visible as far west as Hutchinson, Kansas, where the sun was not yet down. This place is about 475 miles from where the meteor vanished in the southeastern part of Missouri. Both meteors seemed to be traveling in an east-northeast direction. The Nininger Laboratory, in coöperation with the Colorado Museum of Natural History, is directing surveys of both of these falls by means of interviews with local witnesses.

On the evening of January 3, 1936, Mr. R. R. Dollarhide of Morland, Kansas, saw a brilliant meteor which appeared about "twice the size of the Morning Star." This was observed at 10:30 P.M. "in the direction of St. Joseph, Missouri, from a point between Studley and Tasco, Kansas." No other reports of this meteor have reached us.

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[1] *N.S.R.M., P.A.*, **42**, 45-6, 1934.

Finally, on January 24, 1936, at 12:00 M., Mr. Frank Tholburn, a student in the University of New Mexico, at Albuquerque, witnessed the passage of a brilliant daylight meteor which "appeared about one-fourth the size of the full moon." It was observed to the northeast of Albuquerque, traveling in a "northerly direction." Mr. Tholburn conferred with Professor Carroll V. Newsom of the Department of Mathematics in the University and then submitted drawings to us in support of his observations. His report has just been received and a call for reports from other witnesses has been broadcast. The preceding constitute a rather unusual array of large meteors for a sixty-day period in an area of the size involved.

Audible Daylight Meteor Reported Observed Near Coarsegold, California

By FREDERICK C. LEONARD

The following letter, dated January 20, 1936, from Mrs. Kit Whitman of River Route, Madera, California, was received at the Lick Observatory and forwarded to us:

"Last Sunday, January 19, 1936, I happened to be sitting outside of our tent at about 11:00 A.M., P.S.T., when suddenly I heard a terrific swishing noise coming from behind me, apparently from the sky. My dog was about ten feet away, asleep, and she got up and came towards me, starting to bark. I looked up, and, right overhead, seemingly not very high up, as I believe, a rock, or piece of metal, with terrific force passed over me, and continued on about a quarter of a mile towards some big trees and a stream, where it either went into the ground or disappeared. The noise stopped as soon as the object passed overhead. It was going at a great rate of speed, however, and made a swishing noise. It did not go straight [vertically] into the ground, but on a slanting line. The place where I was sitting is high ground, and the thing kept getting lower all the time.

"We are living in a tent outdoors, and there is no one else anywhere near us. We are 7.8 miles by road, southwest of Coarsegold, in the foothills of the Sierras.

"It was a very sunny day, and I was perfectly amazed, first at the noise, which I could not account for, and then to *see* this thing right overhead!

"My husband and I went immediately to the spot where I thought the object might have dropped, but it is very steep there, with tremendous pines and oaks all around.

"I am wondering whether this was a small meteor. It appeared to be of the size of a football, and, as it passed me, the sun was on it, and it was very plain. . ."

We shall welcome any further reports of this meteor, if perchance there were other witnesses of the phenomenon.

Addendum, 1936 February 10.—Since the foregoing account was forwarded for publication, the writer, accompanied by one of his Departmental Assistants, Mr. Henry J. Bruman, and Mr. and Mrs. Colden H. Whitman (Mrs. Kit Whitman and her husband), spent two hours, in the afternoon of February 8, exploring the possible place of fall of this meteor. Unfortunately, nothing was found as a result of the search, which will, however, be continued by Mr. and Mrs. Whitman.

Obituary: Dr. Walter B. Scaife

We announce with sorrow that the Society has lost another of its early members, Dr. Walter B. Scaife of Oakland, California, who died in that city on 1936 January 13, at the age of seventy-seven years. Dr. Scaife, nearly half a century ago, was the first American to receive the Ph.D. degree (in philosophy and his-

tory) from the University of Vienna. A gentleman and a scholar in every sense of the word, the author of two books, and a world traveler, he belonged to an old and prominent Pittsburgh, Pennsylvania, family, and was a brother of the late W. Lucien Scaife, editor of *John A. Brashear: An Autobiography* (Houghton Mifflin Company, 1925). F. C. L.

Secretary's Office: Nininger Laboratory, 1955 Fairfax Street, Denver, Colorado.
Editorial Office: Department of Astronomy, University of California at Los Angeles.

The Leonids

By David A. Blencoe

The near commensurability of the period of the Leonids with that of the periods of the planets Mars, Jupiter, Saturn, Uranus, and Neptune has never, so far as I know, been pointed out. Eight times the period of the Leonids equals nine times that of Saturn or an interval of about two hundred sixty-six years; and five times the period of the Leonids equals nearly eighty-seven times that of Mars, fourteen times that of Jupiter, twice that of Uranus, and about the same as that of Neptune, or about one hundred sixy-six years. This near commensurability of their periods will cause a variation in the period of the Leonids very probably somewhat analogous to that which Halley's comet is shown in *P. A.*, **22**, 191, 192 to exhibit. As meteor streams are supposed to be the debri of comets why should not their periods vary like those of comets?

In *P.A.*, **11**, 6, Professor W. H. Pickering gives a table of years in which the Leonids were observed, namely, 902, 934, 1002, 1101, 1202, 1366, 1533, 1602, 1698, 1799, 1833, 1867, and 1901. Using these dates as a basis, we will add to each, up to 1698, multiples of 166 and also of 266 and form Table I as given below.

TABLE I

1	2	3	4	5	6	7	8	9
902	934	1002	1101	1202	1366	1533	1602	1698
1068	1100	1168	1267	1368	1532	1699	1768	1864
1168	*1200*	*1268*	*1367*	*1468*	*1632*	*1799*	*1868*	
1234	1266	1334	1433	1534	1698	1865	1934	
1400	1432	1500	1599	1700	1864			
1434	*1466*	*1534*	*1635*	*1734*	*1898*			
1566	1598	1666	1765	1866				
1700	*1732*	*1800*	*1899*					
1732	1764	1832	1931					
1898	1930							

The dates obtained by adding 266 are given in italics and the resulting coincidences and near coincidences with the year of apparition of the Leonids are underscored. The coincidences and near coincidences number twenty-four (not counting those of the present period), of which nine are of the 266 and fifteen of the 166 year interval. Both series agree on 1700 and 1898 or six times the Leonid period, say 200 years in round numbers.

Now it can readily be shown that Uranus in 934 and 1101, at the time of the appearance of the Leonids, was near the same place in its orbit, and not so very far from that place in 1602, and it also appears that Neptune at each of these times was near the same place in its orbit. And it may also be remarked that in 1366, 1533, 1698, and 1864 Uranus occupied very nearly the same place in its orbit, and the same can be said of Neptune, which was about one-third of its distance around its orbit from Uranus. Also it can be shown that in 1101, 1367, and 1899 Saturn occupied practically the same place in its orbit. Likewise Jupiter was near the same place in its orbit each 166 years or as in 1366, 1532, 1698, and 1864. From 902 to 1698 is an interval of 796 years. From 1002 to 1799 is an interval 797 years and from 1101 to 1901 is an interval of 800 years, which represent 3 times the 266 year period or 24 times the period of the Leonids.

Now the difference between the 266 and 166 year intervals is just one century, which suggests arranging the occurrences of the Leonids according to the following table:

TABLE II

1	902	1002	1101	1202			1602	1698	1799	1901
2	934					1533			1833	
3					1366				1867	

By this arrangement, we note we have eight appearances near the century years and only five at other times, and we also note a variation from the century year of two years before to two years after. We also note a 400 year interval in the century years, a 600 year and a 300 year interval in those at the close of the first one-third of the century, and a 500 year interval at the close of the second third of a century.

It will be seen that between 902 and 934, we have a 32 year period and between 934 and 1002 we have an average period of 34 years, between 1002 and 1101 an average period of 33 years, between 1101 and 1202 of 33⅓ years, between 1202 and 1366 of 33.4 years, from 1533 to 1602 of 34.5 years, from 1602 to 1698 of 32 years, from 1698 to 1799 of 33⅓ years, and from 1799 to 1901 the periods are each 34 years in length. The mean length of the period between 902 and 1901 is 33.3 years, covering 30 orbital periods, with a variation on each side of the mean of perhaps 1.7 years. The interval between 1202 and 1366 is 164 years, while that between 1366 and 1533 is 167 years, that from 1533 to 1698 is 165 years, and that from 1698 to 1867 is 169 years, a variation of five years, and this interval represents five periods of the Leonids. It shows that the *Mean* period during these different intervals varies as much as one year, from 32.8 years to 33.8 years, and it is very probable that the individual periods vary in length from 31 to 35 years. Table III is an arrangement of the probable length of the period in 200 year intervals, beginning with the year 902, and proceeding downward.

TABLE III

1	2	3	4	5
32	32	31	32	32
33	34	33	34	34
35	35	35	35	35
35	35	35	33	34
33	34	33	32	34
31	31	32	31	34

It may be here noted that each of the years 1234, 1400, 1566, and 1732, as given in Table I column 1, was preceded one period earlier by an appearance of the Leonids, while the Leonids were seen one period later than the dates 1168, 1334,

1500, and 1666 as given in column 3 of the same table. There are other similar cases.

The Perseids also are probably cyclic in character as regards their period, for four times their period is nearly forty-two times Jupiter's, seventeen times that of Saturn, six times that of Uranus, and three times that of Neptune. In fact, all or nearly all the comets and meteor swarms are subject to these "cycles."

It would seem that here is a good field for the mathematician.

Alma Center, Wisconsin.

Meteor Observation

On the evening of October 23, 1935, I observed a remarkable meteor. I first noticed the meteor while I was observing W Lyrae at 7:20 P.M., C.S.T. My attention was attracted to it by the glare from it.

The first star it passed was about 2° west of ϵ Equulei which then was but a few minutes west of my meridian. It moved into Pegasus and Andromeda. When near δ Andromedae it broke into about half a dozen small pieces and all traveled slowly together into Perseus toward Algol where the spectacle ended.

The color was a blue-white at the front and tinged about the outer edges with orange. The trail was a lighter blue than the main body but this lasted only a short time. The smaller bodies assumed a red orange and all left small white trains. The duration was 2 to 3 seconds estimated by a stop watch.

My position is latitude 41° 31′ 34″ and longitude 90° 32′ 54″.

929 Grand Avenue, Davenport, Iowa. ARTHUR DE VANY.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

New Observers and Observations: New observers for January include Messrs. Lancaster Hiett, Hedgeville, West Virginia; Yoshifusa Okano, Aichi-Ken, Japan; Emil A. Sill, Mamaroneck, New York; and Joseph Skinner, Kagawaken, Japan.

In the first quarterly report of the work of the Association to appear in the *Harvard Annals*, 104, No. 1, are contained approximately 10,000 observations on more than 400 variables of long period and irregular types, by more than 100 observers. These include observations received during the months of November, December, and January. Although results are being printed quarterly, observers are expected to continue to contribute their observations monthly, in order to facilitate the handling of the data at headquarters, and to aid in compiling the bi-monthly predictions.

Recent A.A.V.S.O. Publications: The latest issue of the A.A.V.S.O. Bulletin containing the bi-monthly predictions of magnitudes of long-period variables, as of March 1, was distributed to all active observers in the Association. Numbers 1-4 of Volume 3 of Variable Comments have just come from the press and are being mailed to all A.A.V.S.O. members. They contain an account of The Twenty-Fourth Annual Spring Meeting, May, 1935, by Percy W. Witherell; a report on

The International Astronomical Union in Paris, 1935, by Annie J. Cannon; the Fourth Annual Report of the Pickering Memorial Astronomer, 1934-35, by Leon Campbell; and an account of The A.A.V.S.O. Meeting at the Harvard College Observatory, October, 1935, by Marjorie B. Leavens.

Red Variable Program: The plan to observe some of the reddest of the variables—R Leporis, RS Cygni, etc.—by means of the use of specially prepared red filters and with special sequences with assigned comparison star values in terms of the red magnitude scale, has been inaugurated. Although in the beginning only a few of the more experienced observers have been requested to take part in this scheme, we hope, after details have been worked out, to have the assistance of more members. The purpose of the red variable program is to attempt to study the light variations of these variables in the visual red portion of the spectrum where it is possible that the variations differ in character from those observed in the normal visual spectrum.

SU Tauri: The recent decrease in the light of SU Tauri, one of the R Coronae Borealis type variables, was of minor extent, amounting to about a magnitude only, and the star has now reached normal maximum magnitude 10.0.

SS Cygni Type Variables: Maximum 282 of SS Cygni, which occurred early in January and proved to be of the A8 form of curve—steep rise, wide maximum—was quite completely observed. The next increase to maximum may be expected to occur between March 3 and 10. Before SS Cygni had reached minimum, SS Aurigae and U Geminorum were each at maximum, both maxima were of the narrow type; both variables were well observed on the increase to maximum, thus well defining the form of light curve. For U Geminorum, the interval between the last two maxima was about 90 days, while for SS Aurigae the interval was about 60 days.

An excellent series of observations on SS Cygni has just been received from members of the Astronomisk Selskab, at Copenhagen, for the year 1935. This material will greatly augment the data already on hand for this interesting variable. The observations were made by Messrs. Bull, Holmberg, Larsson, Nicolaisen, and Östergaard, and were reduced by Mr. A. V. Nielsen.

Nova Herculis: Recent observations of Nova Herculis, though few in number, due to its unfavorable position in the sky, indicate little change in magnitude during the past few months; now approximately at seventh magnitude. This nova continues to follow the curve of its prototype, Nova Aurigae 1892, which required many years to decrease in light to its normal minimum magnitude after the secondary outburst.

Bright Variables: Several well-known variable stars will be bright, at or near maximum, during March:

R Boo	143228	R Sct	184205
R CrB	154428	χ Cyg	194632
R Crv	170215	T Cep	210868

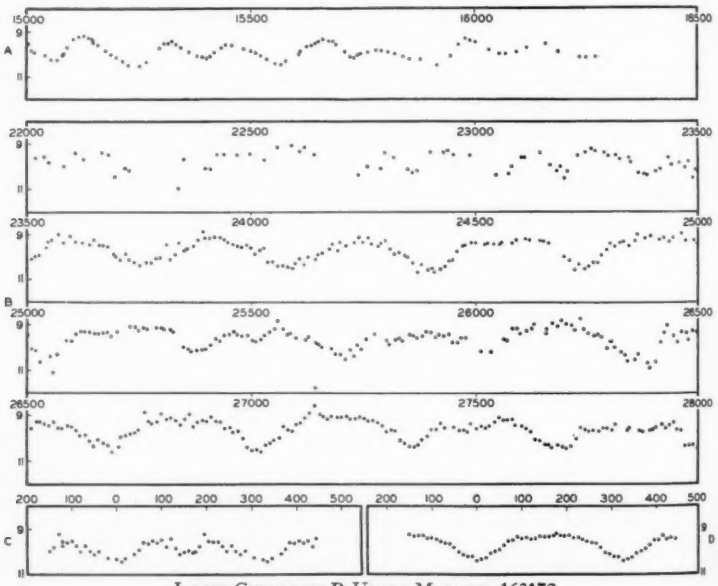
Beta Persei, better known as Algol, should be at minimum on the following dates during March and April:

1936	d	E. S. T.	1936	d	E. S. T.
March	9	3h6 A.M.	April	6	7h7 P.M.
	12	12.4 A.M.		9	4.6 P.M.
	14	9.2 P.M.		21	3.9 A.M.
	17	6.0 P.M.		26	9.4 P.M.
April	1	2.1 A.M.		29	6.2 P.M.
	3	10.9 P.M.			

The variable star Alpha Orionis is in good position for naked-eye estimation. Well-known comparison stars are: α Aur, 0.2, β Ori, 0.3, α CMi, 0.5, β Gem, 1.2, and α Tau, 1.1. When making estimates of the variable, one should be careful to select the comparison stars, or star, which do not differ too greatly in altitude from the variable. Estimations of brightness should be by the short quick-glance method, to avoid the Purkinje effect, whereby red stars when gazed at too long so excite the retina of the eye as to cause the star to appear unduly bright when compared with stars which are not quite so red in color.

New Publications: Congratulations to the Riverview College Observatory, at Sydney, Australia, on the issuance of its first publication, dated November, 1935. This publication is devoted entirely to the photographic observations of variable stars and should be of interest to all variable star observers. The notes in this very interesting publication cover newly discovered variables, especially of the Cepheid and eclipsing types, as well as a discussion of the long-period variable AL Centauri. The authors are, D. O'Connell, S.J., and W. O'Leary, S.J. Father O'Connell spent nearly two years at Harvard Observatory studying variables on the photographic plates before he took up his post at Sydney.

R Ursae Minoris: Long-period variables of relatively small range are usually rather difficult to observe by the ordinary visual estimate method in vogue with variable star observers. Yet, in spite of this difficulty, the observational material so far gathered by the A.A.V.S.O. is rather satisfactory and does give data as to the form of light curve and period. On account of the small range assigned to the star by earlier observers, Professor O. C. Wendell, using the polarizing photometer attached to the 15-inch Equatorial at the Harvard Observatory, observed the variable between the years 1899 to 1903. The degree of accuracy attainable



LIGHT CURVES OF R URSAE MINORIS, 163172

with this instrument has been exceeded only by modern photo-electric methods. Wendell's observations reveal a period of about 325 days, with evidence of a marked secondary minimum approximately half way between the principal minima. The maximal range, found by Wendell, was 1.4 magnitudes, with a minimal range of less than a magnitude. The individual observations as made by Wendell are plotted in the curve marked "A" in the accompanying plate.

The A.A.V.S.O. observations of this star from 1919 to 1935 are plotted under ten-day means and are shown in curve "B." Here, of course, there is a greater amount of scattering but the general outline of the variations is well shown. The observations in later years were considerably more numerous and, accordingly, the mean curve is much smoother at that time. The marked secondary minima, found by Wendell, are less in evidence in the A.A.V.S.O. observations but indicated, more in the form of a still-stand.

The mean light curve as derived by the relatively few, but excellent, observations of Wendell is shown in curve "C" and that from the A.A.V.S.O. observations in curve "D." Curve "C" is not as smooth as "D" but this is probably due to the anomalous character of the star itself. Curve "D" is naturally smoother because of the greater number of observations and the greater length of time over which they extend.

Perhaps there is a suggestion of a change, in a quarter of a century, of the form of the light curve from one with a marked secondary minimum to one with a more rounded maximum with a still-stand. R Ursae Minoris appears to present a light curve having many similarities to U Persei, 015254. It will be noted that the mean light curves, as indicated in figures "C" and "D" have been referred to minimum as the zero point.

Caroline E. Furness: With the passing of Dr. Caroline E. Furness, Director of the Vassar College Observatory, variable star astronomy has lost a valued enthusiast and ardent supporter. Miss Furness had long been a member of our Association and, in her early years at Vassar, had maintained a regular program of observing variable stars, not only for herself but also for her students. She served at one time as a member of the Council of the A.A.V.S.O. Two meetings of the Association were held, at her invitation, at the Vassar College Observatory. Her book, "An Introduction to the Study of Variable Stars" was a pioneer volume in the study of variable star astronomy and the most extensive work of its kind written in English—a sort of "Vade Mecum" for variable star observers.

February 17, 1936.

An Illuminated Reversing Box for Star Charts

The simple apparatus described below was demonstrated at the spring meeting of the Variable Star Observers (AAVSO) on May 25, and has been so helpful to the author in finding and estimating variables with his Springfield mounted reflector that he thinks it may help other amateurs who have the same difficulty in matching their star fields with the AAVSO star charts. With the Springfield mount or a refractor with diagonal eyepiece the star chart must be seen reversed by a plane mirror in order to make the compass points match the telescopic field.

I do not claim this mirror-box as my invention, as I only improved the similar box used by Mr. Leon Campbell at the Harvard Observatory with the Gerrish polar telescope.

The optical principle of the mirror-box is that by placing the star chart face down on the glass top at an angle of 30° to the plane mirror on the bottom, the image of the chart is seen, when one looks into the front, nearly at right angles

to the line of vision but reversed so that the lower end of chart is above and the upper end below. When the chart is then turned on the glass top in such a way that West corresponds in direction with West in the telescopic field, all the compass points will agree and the fields will match.

My chief improvement was to put a weak flash-light bulb inside the box, connect it with a dry cell on the stand below, and so place and shade the light that it illuminates the chart properly and yet does not shine into one's eyes, directly or indirectly, when one looks into the box at the correct angle. The best place for the light is at the center of the front edge of the mirror, and it must be screened by a wooden strip of the right width about 4½ inches. I prefer a white light to read the small magnitude figures, but some may prefer a red bulb, which may be bought at any electric store. I find a cord switch very useful to turn off the box light when I wish darkness for estimating the magnitude of the variable. The inside of box should be painted matte black.

In using the box with the Springfield mount, as the eye is always at the same level as the eyepiece, the box should be set on a movable stand or shelf at the right height, so that one looks conveniently down into it at the correct angle, about 30°. For convenience it should be easily movable from one side of the pier to the other. I have my box at present on a light wooden stand 52 inches high; the top is a bit narrower than the box, and cleats on the bottom of the box hold it securely yet permit sliding it a bit nearer or farther to adjust the visual angle. A more convenient arrangement would be a long, extensible, swinging bracket such as dentists use, attached to the observatory wall in such a way that it could easily be swung to either side of the pier and towards or away from the observer.

The formation of dew on the mirror or under surface of glass top is easily prevented by a strip of glass over the front opening, held in place by four small right-angle hooks.

SPECIFICATIONS

Wooden parts of ¾-inch triple-ply board. (The artificial "masonite" has been suggested to me as lighter and more resistant to weather.) The mirror 11x12, of good quality, preferably plate glass. Frame of felt-lined weather strip. Flat brass strips across corners of frame hold mirror. Flash-light bulb is 2.4 watts, in bicycle lamp socket. Cord runs down to dry cell on shelf of stand.

The box angles must be just 30° at the rear and 60° in front. The cord switch is not necessary but very convenient.

The glass top, size 12x12½, is set in a frame with putty. A light board, 12x12, is put over the chart on the glass top to hold it in place and also to confine the light inside the box. It is prevented from sliding off by two screws or hooks at lower end.

Anyone who may desire further suggestions is requested to write to the author.

WILLIAM L. HOLT, M.D.

Scarboro, Maine.

Notes from Amateurs

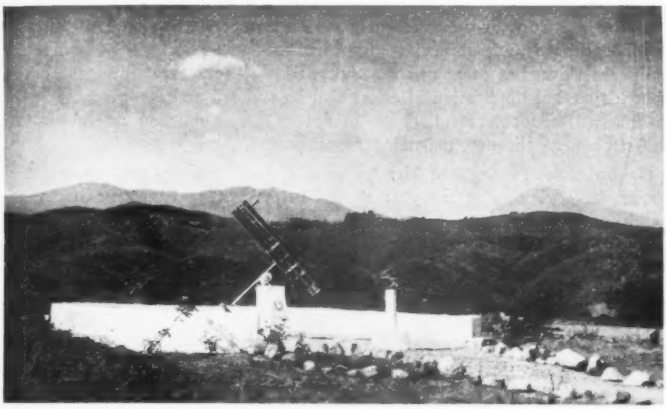
An Outdoor Observatory

The Glory of God is to conceal a thing: but the honor of kings is to search out a matter (Prov. 25, 2).

Last spring a group of boys of the Webb School of California, Claremont, started to search out a matter—the heavens for height—with the aid of a home-

made observatory. The boys did most of the work on the wall of the observatory, while I, with the generous advice and help from certain members of the Amateur Astronomical Society of Los Angeles, ground the mirror for the telescope. In due time we had things in full operation.

Our Newtonian reflector has an 8-inch mirror of pyrex, the focal length of which is 70 inches. It is held in a cell of wood and galvanized iron and when not in use is protected by a cap. The tube is made of iron rings and oak strips and weighs 45 pounds. The telescope fits on to an equatorial mounting held solidly in a concrete base. The polar axis is made of a 1-inch iron rod, around which fits a water pipe, which has welded to it a ring gear and the axis of declination. This axis is made of a water pipe, so that the holder of the telescope can slip into one end and the balance, two ring gears welded to an iron rod, into the other. The tube is free to rotate in its holder, so that the eyepiece can be brought to any convenient position. We have three eyepieces with focal lengths of one, one-half, and one-quarter inches.



Eight-inch Reflector of the Outdoor Observatory

The picture shows the telescope mounted in the observatory which has as its dome the garnished heavens. The observatory is situated on the edge of the campus where seeing conditions are ideal for amateurs. The wall is of concrete, six inches thick and eighteen inches high. It has a wide opening, in the middle of which is a three ringed armillary sun dial. Around the inside wall are painted the signs of the zodiac, and on the mount and armillary are painted the planetary signs. The floor is of crushed rock; the outside decorations, rose bushes.

On three occasions we spent all night sessions in search of sidereal secrets and got intimately acquainted with the moon and its craters, mountains, shadows, and occultations; Jupiter and its four principal moons; Venus and its phases; Saturn and its moons and rings; and double stars, star clusters, and nebulae.

We haven't yet found the exact height of the heavens. But we have found something—i.e., we look to the heavens more often with "bowed heads and humble hearts." We are organizing an astronomy hobby-club.

Claremont, California. Raymond M. Alf.

The Chicago Amateur Astronomical Association

The Amateur Telescope Makers of Chicago met in the Adler Planetarium and Astronomical Museum on Sunday afternoon, February 2. The meeting was called to order by Professor Arthur Howe Carpenter, President. A motion was made and seconded that the name of the club be changed from the Amateur Telescope Makers of Chicago to The Chicago Amateur Astronomical Association. The motion was carried unanimously so the club will now function under the new name. It is thought that the new name will have a greater appeal to those who are interested in astronomy and who have no desire or facilities to make their own instruments. Of course the telescope making activities will go on as usual and the members will be urged to do systematic observing in any of the fields open to the amateur.

Mr. L. E. Armfield, secretary of the Milwaukee Astronomical Society, was the speaker. The subject of his address was the "American Amateur Astronomical Association," or the 4A as it is generally called. This organization is an affiliation of a number of the amateur clubs and is growing rapidly. Its object is to systematize the work of the different groups of amateur observers. The member clubs coöperate in their observing programs, leaders are or will be appointed for the different branches of amateur activity. The leaders will direct the work in their fields so that duplication of effort will be avoided and records kept in such a form that will be most useful. The observations are published monthly in "Amateur Astronomy," the new magazine for amateurs.

We are much indebted to Mr. Armfield for his inspiring address which coming near the beginning of the year should help to make 1936 an active year for the Chicago amateurs.

WM. CALLUM.

1319 West 78th Street, Chicago, Illinois.

Asteroid Notes

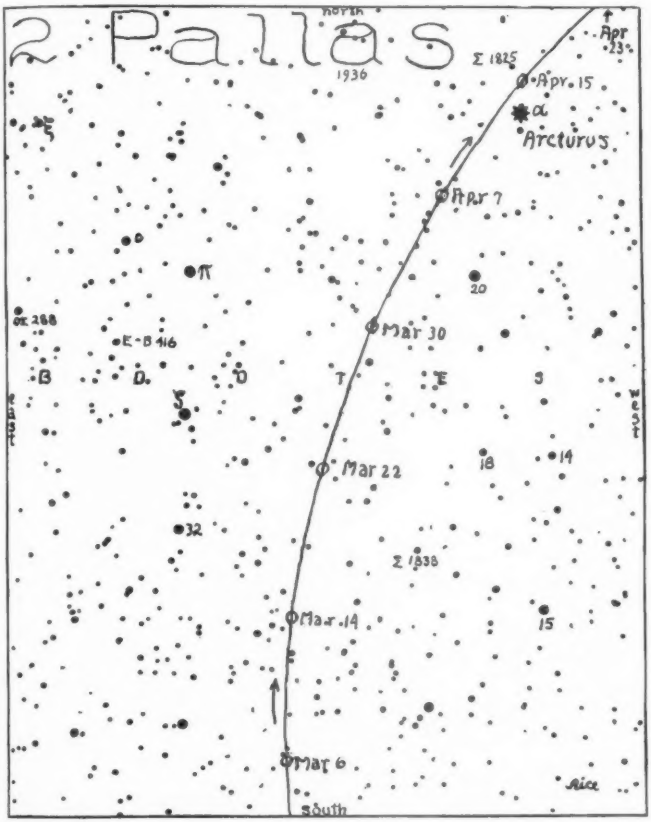
By HUGH S. RICE

Among the asteroids the Big Four are the largest and best known ones, and the minor planets easiest to observe. This term (Big Four) was coined seemingly by our esteemed observer Mr. Saunders of Baltimore, who is still (!) following Vesta, which before long will be lost in the rays of the setting sun. This object was first picked up by him from our apparent path in the June-July issue of this magazine. It ran off the chart at the end of the year, but is still being pursued by this enthusiastic atronomer, and he had made 117 separate observations up to December 6. It is quite to the credit of an observer not to lose it during the winter season, and at a time when there is neither ephemeris nor charted path.

Planet 2, Pallas, is now coming into another apparition, as one says in the case of comets. We offer therefore a chart of its path among the stars. Pallas was discovered by Olbers in March, 1802, while he was searching for Ceres, which had been lost while in conjunction with the sun. Olbers found an object of 7th magnitude in Virgo where he knew there was no star before. Its position, moreover, changed visibly in a few hours' time, according to one Dionysius Lardner.

Pallas has a period around the sun of $1681^d.1$ which is found by dividing 360° by its mean daily motion of $768''.708$ as given under "Elemente" in the data by the *Astronomisches Rechen-Institut.* Its distance from the earth on March 15 will be

1.69 astronomical units, or 157,000,000 miles; its magnitude will be 7M.6, or brighter than Neptune. Its course is nearly northward in Boötes, and our positions refer to 6:00 P.M., E.S.T. It passes by Arcturus on April 13 and 14, and about ¼° northeast of this yellow super-giant.



1, Ceres, will be favoring us with its appearance this spring in Libra. Even now it is rising about 6 hours before the sun. For anyone who wants to locate Ceres without ephemeris or chart, it may be stated that for quite a number of days around the middle and latter part of March it will be about a degree west of ξ Scorpii, with magnitude 7M.7; this improves to 7M.3 in May, when it will be in a more convenient place for observation.

Hayden Planetarium, American Museum of Natural History,
New York City, February 20, 1936.

General Notes

Dr. Caroline Furness, for many years Professor of Astronomy and Director of the Observatory at Vassar College, died in New York City on February 9. She had been in a hospital there since October and had been in poor health for some years.

Phillips-Lenard Institut.—This is the name given to what was formerly known as the Physikalisches Institut at the University of Heidelberg. The dedication of this new institution took place on December 13, 1935. A number of prominent German scientists participated in it.

The Rittenhouse Astronomical Society of Philadelphia held a meeting on Friday evening, February 14, in the Hall of The Franklin Institute, Twentieth Street and the Parkway. An address on the subject, "Glass for the Astronomer from Galileo to the 200-inch Disc," illustrated with slides and sound motion pictures, was given by Dr. John C. Hostetter, Director of Development and Research, The Corning Glass Works.

Astronomical Bulletin.—Circular No. 149, and Bulletins Nos. 150, 151, of the New South Wales Astronomical Society have recently been received. They are in mimeographed form, and contain brief notes and some longer articles. One which affords interesting reading is the description by Mr. Arthur Davis of a visit he made to the large astronomical observatories in California. Several articles pertain to the art of telescope making by amateurs, a hobby which seems to be spreading widely.

Amateur Astronomy, the official monthly publication of American Amateur Astronomical Association (A.A.A.A.), is appearing in a new form beginning with the issue for January, 1936, which is number 1 of Volume 2. The new form is a regularly printed pamphlet of twelve pages. Heretofore it has been a collection of mimeographed material from the several societies of amateurs which constitute the Association. It is to be issued monthly at a subscription price of ten cents per copy, one dollar per year.

Lunar Maps.—For use at the telescope a limited number of photographic reproductions on reduced scale have been made of the Maps contained in Vol. II of the "Named Lunar Formations" by Mary A. Blagg and K. Müller, published by the International Astronomical Union.

Orders for the reduced map which consists of 14 prints of 5x8-inch size (price 1½ guilders, or 4 shillings) should be sent to the General Secretary of the Union, Profesor J. H. Oort, Sterrewacht, Leiden.

Observatory at Chattanooga.—Plans for a public observatory as a part of the school system of Chattanooga, Tennessee, are well under way. Specifications for the observatory have been made by Mr. Clarence T. Jones, a local architect. It will cost approximately $14,000, and will contain as its principal instrument a 20-inch reflector. It will be carried through as a PWA project. The Barnard Astronomical Society, named for the late Edward E. Barnard of the Yerkes Observatory, originated and is sponsoring the project.

Simon Newcomb Memorial.—On August 30, 1935, in Wallace, Nova Scotia, the birthplace of Simon Newcomb, a fine stone monument with a bronze tablet containing a suitable inscription was unveiled in memory of the great astronomer. In this connection the fact that, shortly before his death, Simon Newcomb by international vote was listed as the leading astronomer of the world was brought to light. In November, 1935, Newcomb was elected to the Hall of Fame of New York University. He was born in 1835 and died in 1909.

The Gold Medal of the Royal Astronomical Society for 1936, has been awarded to Professor H. Kimura, since 1899 Director of the International Latitude Observatory at Mizusawa in Japan. This is the first time that this medal has gone to Asia, or in fact to any country outside of Europe or North America. Professor Kimura has devoted the major part of his activities to a study of the variations of latitude and since 1919 he has been president of that commission in the International Astronomical Union. His principal discovery relates to the existence of a small variation that is constant with respect to the longitude of the station, but which varies with its latitude. It is in great part owing to his flair for discussing such observations that the latitude results have reached their extraordinarily high degree of precision.

Paris Academy of Sciences Prize Awards for 1935.—In *Nature*, January 18, 1936, is given a long list of prizes granted by the Paris Academy of Sciences in 1935. These were announced at the public annual meeting of the Academy on December 16.

Prizes were awarded in astronomy as follows:

The Lalande Prize to Lucien d'Azambuja, for the whole of his work; the Damoiseau Prize, in equal parts, between Guy Reiss and André Patry, for the whole of their work; the Benjamin Valz Prize to Raymond Tremblot, for the whole of his work; the Pierre Guzman Prize, in equal parts, between Jules Baillaud, André Danjon, and Armand Lambert, for the whole of their work; the G. de Pontécoulant Prize to Georges Durand, for the whole of his work; the Le Caille Prize to Raoul Goudey, for his studies relating to the intensity of gravity.

The Vortical Motion of the Clouds of Jupiter

During the last years, Jupiter attracted the general attention of the observers, because of numerous changes in the structure of details on the surface. It also attracted attention because of the very good conditions for observations and because of the desire to learn its real nature.

We know very much about the nature of Jupiter, but, in spite of this, questions concerning the nature of the dark and bright details on the surface are widely discussed among observers.

Such a phenomenon as the crossing of a total solar eclipse cannot pass without leaving a trace in the earth's atmosphere. It changes temporarily the atmospheric pressure, temperature, and other hygrothermal conditions in our atmosphere.

The same changes are probably produced also on the surface of Jupiter by the crossing of the streak of a total solar eclipse which changes the circulation of the atmosphere.

I was convinced of that on 22 November 1928, when I observed the shadow of the first satellite passing across the disk of Jupiter between $18^h\ 00^m$ and $20^h\ 10^m$ G.M.T.

There was noticed at $18^h\,15^m$, at $\lambda = 7$, an accumulation of bright details in the South Temperate Zone with a bright prolongation which crossed the Temperate-Tropical Belt. The red spot was disappearing from view. In the center, to the east from the red spot was seen a very interesting formation of the Temperate-Tropical Belt with an unusual structure. At $19^h\,00^m$ the prolongation was crossed by the shadow of the first satellite and after this it was somewhat dispersed. Only a slight white fog rested on this place, which increased the brightness of the surrounding bright details. At $19^h\,10^m$ there were only three bright areas. At $19^h\,55^m$ these bright areas moved rapidly after the shadow, which was moving away.

These bright details reminded me, because of their movement, of a vortex in the center of which were two dark spots, the behavior of which resembled the red spot in respect to the repelling influence of the latter on the surrounding clouds.

It is possible that the construction of such spots is very similar to the construction of the sunspots.

I am convinced that the bright spots on the surface of Jupiter are clouds and the dark spots also are cloud but of another formation. The observations were made with the 4-inch refractor and 6½-inch reflector.

Kharkow, U.S.S.R., Ukraine. G. S. MELICHOV.

A Solar Halo

At 11:00 A.M., Central Standard Time, July 3, 1935, my attention was called to a solar halo. The sun was near the zenith at the time and in front of it was a thin veil of clouds which were undoubtedly the cause of the phenomenon. I was then located at Mazatlan, Mexico.

The halo itself was probably of the 46° variety and as usual had the red on the inside. The other colors were all visible but the blue was exceedingly pale and shaded to a band of white light on the outer edge. Due to the variable density of the veil of clouds the intensity of the halo was not the same at all places and disappeared entirely at one point. There were no other phenomena such as sun dogs, arcs, etc., except a colorless corona closely surrounding the sun.

I did not observe the final disappearance of the halo but it gradually faded until it was very faint and contained several gaps at 11:10.

99 South Raymond Avenue, Pasadena, California. JOHN BUDDHUE.

Book Reviews

Mathematics and the Question of Cosmic Mind with other essays, by Cassius Jackson Keyser, Adrian Professor Emeritus of Mathematics, Columbia University. (Scripta Mathematica, New York. 1935. pp. v +121.)

This, the second volume in The Scripta Mathematica Library, is a collection of six essays that have appeared with slight modification in current journals. The first three, the last of which furnishes the title to the volume, are an exposition of the thesis that "mathematics is a well nigh perfect model for all other educational disciplines in so far as these have, ultimately, for their main concern the handling of ideas as such." As the quotation suggests, these essays deal with the philosophical foundation of mathematics, and the essential relation of mathematics to science and to the field of general human interests.

At a time when the need of mathematics in a liberal education is being

questioned, the volume is a welcome advocate. Teachers will find it interesting and to many the discussion of the "postulational function" will be a fresh point of view.

The remaining essays are entitled "Mitigating the tragedy of our modern culture"; "On the study of Legal Science," and "William Benjamin Smith."

M. B. W.

The Binary Stars, by Robert Grant Aitken. (McGraw-Hill Book Company, Inc., New York and London, 1935. $3.75).

It is helpful in every department of science and in every field within a science occasionally to take account of stock. Annual reviews of the noteworthy achievements in astronomy appear in various journals. But because the significance of current observations or new theories is often not at once apparent, we find summaries of work in various fields of great value.

In 1918 Dr. Robert Grant Aitken in *The Binary Stars* presented an excellent summary in the field of double stars. There had been no comprehensive survey in this field since *The Handbook of Double Stars* by Crossley, Gledhill and Wilson, published in 1879. Aitken's volume served then an excellent purpose, stimulating still further the interest newly awakened by the appearance of Burnham's *General Catalogue of Double Stars.*

The present or second edition of *The Binary Stars,* 1935, brings the consideration fairly up to date. The interval between the two editions has witnessed the publication of Aitken's great *New General Catalogue of Double Stars;* the continuation of the survey by Espin and Milburn; great progress in the survey of the southern sky by Hussey, Dawson, Rossiter, and Van den Bos, resulting in many new and important discoveries; the appearance in 1927 of the loose leaf *Catalogue of Southern Double Stars* by Innes; the publication of a resumé of double star astronomy by Baize in five numbers of the 1930-31 volumes of *L'Astronomie;* and excellent sets of measures by many observers. In the field of spectroscopic binaries the activity has been equally great. Whereas when the original edition appeared there were 87 orbits of visual binaries available and 137 spectroscopic binary orbits, the new edition cites 116 visual and 326 spectroscopic. Burnham's *General Catalogue of Double Stars* contains 13,665 entries; Aitken's, though he rejected many stars from Burnham's catalogue, contains 17,181. The number of known spectroscopic binaries had jumped from 140 in 1910 to 1340 in 1931.

The new volume follows the general outline of the earlier one very closely, many paragraphs or even pages are practically unchanged. The historical sketch in the first two chapters and the chapter on observing methods are little changed except that the rôle of photography is emphasized and the use of the interferometer is discussed. The interferometer still presents curious anomalies. I agree with the author that "further investigation is required before it can be accepted as a standard instrument for double star observation."

In the chapter on orbits there is new material provided in an ample discussion of the Thiele method, or rather, the Innes modification of Thiele, with an illustrative example, the computation for 24 Aquarii. In discussing the evidence offered by double star orbits for the universality of the Law of Gravitation, the author should have mentioned the brilliant papers by Darboux and by Halphen.

The excellent chapters on radial velocity and orbits of spectroscopic binaries, written by Dr. J. H. Moore, leave nothing to be desired in clarity and content. There is a revision of the description of the spectral classes with a much finer

Plate III to illustrate their characteristics. There is brief but clear exposition of the methods of taking spectrograms, their measurement and reduction, with attention called to the various necessary precautions.

The fact that Aitken includes, and very logically, the discussion of spectroscopic binaries in his volume, calls to mind a letter which I received from a distinguished American astronomer shortly after beginning my work at the Dearborn Observatory. The writer wished to know why I was wasting my time on double stars. The writer of the letter was putting his major effort at the time on spectroscopic binaries. I answered stating that the old mounting of the 18½-inch refractor was so shaky that photographic and spectroscopic observations were out of the question. Moreover, since the telescope had through Burnham and Hough made notable contributions in this field, it seemed logical to continue the program. Besides, from previous association with Burnham and Barnard I had great interest in double stars. I concluded my reply with the question as to whether we were not after all attacking the same problem with different tools. Each gives some information beyond the other's grasp. These coördinating contributions are brought out clearly in the general discussions in this volume.

The inclusion of a discussion of eclipsing binaries is also to be commended as rounding out the various methods of approach to double stars. When the photometric observations are supported by spectrographic observations the information obtained "provides the most complete knowledge of a stellar system that we can hope for at present—masses, linear diameters, densities, surface brightness, and even something regarding the law of internal density." Aitken might have added, "rotation." In the interval between the two editions the number of known eclipsing binaries had jumped from 150 to nearly 1000.

The general considerations and statistical surveys of the last chapters have brought out no new relationships but in some cases strikingly confirm conclusions based on the earlier more meager evidence. The progressive increase of eccentricity with period first clearly indicated by See is strongly reinforced. New evidence presented by Russell extends the range to doubles of very long period, with further affirmation. This relationship is one which must be of prime importance in the evolution of binary stars. I have found no mention in this volume of its place in the arguments on the time scale of the universe. The other relationships considered are those of: 1. Period and spectral class. The early types show in general shorter period than the late types but the progression is irregular. 2. Eccentricity and spectral class. Not proven. 3. Absolute magnitude, spectral class, period, eccentricity. Nothing significant. 4. The curious and rather startling concentration in the distribution of longitudes of periastrons pointed out by J. Millar-Barr. Seems with additional data to be doubtful. 5. The orientation of the orbital planes. There seems to be no preferential direction. 6. Masses and spectral types, the components with respect to each other. The adoption of the practices of tying in a third star where available and observing the radial velocity of the components independently, to increase the knowledge of relative masses, should be strongly urged. 7. Dynamical parallax enters as a new item. "Dynamical parallaxes are statistically of a high order of accuracy." 8. Density of Binary Stars. 9. Multiple stars. It is of interest to see that the close pairs in multiple systems in general revolve in the same direction as the wider components. In all the considerations of this chapter the author emphasizes wisely the fact that the conclusions rest upon comparatively few pairs and that some of the material may be highly selective. The treatment is soundly judicial.

In Chapter IX the author considers in detail a selected list of binaries bringing

out many points of interest. Under 61 Cygni appears the statement that "Burnham clearly intimated that he thought the pair an optical one." I believe this must be a misinterpretation for in the several years of close association with Burnham I frequently heard him refer to common proper motion as definite evidence of binary character and specifically to 61 Cygni as a binary.

That one can get an impression from personal contact somewhat different from that obtained from literature is brought out again under HD 698 on page 251. Dr. Aitken mentions there Hartmann's explanation of the stationary calcium lines. I know that Hartmann considered the clouds as very extensive perhaps pervading the whole galaxy. On page 252 there is mention of "Eddington's hypothetical cloud." I cannot say whether Hartmann considered the cloud as having the remarkable quality of uniform density. This alone seems to be the point of difference if there is any. If the cloud has uniform density the intensity of the calcium lines would give a critical indication of parallax. I do not understand the meaning of the statement "the mean distance of the cloud is about half the average distance of the stars" unless it means simply that the cloud has uniform density.

Under Algol, I find no mention of Schlesinger's suggestion of the method of observing the rotation by the narrowing of the lines and their differential displacement though the subsequent contributions by Rossiter, McLaughlin, Struve, are cited.

In the chapter on Statistical Data the author utilized the more extensive material available in the *New General Catalogue of Double Stars*, the more numerous parallaxes, the spectral classes of the Draper Catalogue, Leonard's important work on the spectra of the components of double stars, also the more accurate apparent magnitudes of double stars, but brought out little that is new.

In discussing the percentage of double stars the figures in Table 4 seem to justify the statement made in italics, "Close visual double stars are relatively more numerous in low than in high galactic latitudes," but I fail to understand the proffered explanation that this concentration is due to perspective unless this means that we are to regard a very considerable percentage of the close double stars found in low galactic latitudes as optical pairs.

In the final chapter on the Origin of Binary Stars, Dr. Aitken has set forth more distinctly the characteristics of double stars and the important conclusions drawn from the observations that must be accounted for in any acceptable theory of their origin. The three theories, capture, fission, separate nuclei, are discussed but with the conclusion: "No theory of that origin and of the subsequent development that has so far been formulated can be regarded as satisfactory." In the matter of capture it is surprising that Aitken does not consider the possibility of non-elliptic orbits. It is quite reasonable to suppose that the components of some of the pairs in which motion is slow but in which curvature is shown may not be permanently associated. Baize has discussed this idea in *L'Astronomie* of July, August, September, 1933.

The volume ends with two valuable and comprehensive tables: Orbits of Visual Binary Stars, Orbits of Spectroscopic Binary Stars.

I have noted a few minor errors. On page 34 Paramatta is spelled "Parametta." This misspelling occurs also in the first edition. On page 22 it is stated that Burnham continued as clerk of the Federal Court "until 1910." He resigned in 1902. On page 222, BD +6°1308 should probably read BD +6°1309. On page 288 the authority for the orbit of 13 Ceti should be Pogo not "Pago." I would note also that while I agree that Smythe's Cycle of Celestial Objects "became justly

popular," I would not use the word "justly" as found on page 18 in referring to the popularity of the Bedford Catalogue.

The volume is valuable in itself as an authoritative summary. Moreover, it reveals clearly that the author in his close attention to double stars, their discovery, observation, orbital determinations, and statistical considerations, held clearly and fixedly toward his own professed objective of "providing additional data for the study of the greater questions of the origin and evolution of the binary star systems and of their relation to single stars."

PHILIP FOX.

14 February 1936.

Astro-Kalendar, by Richard Sommer. (Johann Ambrosius Barth, Leipzig. 3 marks.)

The above is the name of a pamphlet of 40 pages of astronomical tables. It contains such information as is to be found in the *American Ephemeris and Nautical Almanac* and the annual volumes corresponding to it published in other countries. It does not claim to take the place of the larger publications but, as far as it goes, the information is in a compact and readily usable form.

The tables cover quite completely the phenomena of the solar system, and also include data relating to variable stars and double stars.

It seems there must have been a slight change of plan after the table of contents was printed, for the last two items of the table of contents are not to be found in the pamphlet, and the last table given, namely, one for converting hours and minutes into decimals of a day, is not listed in the contents.

Katalog und Ephemeriden Veränderlicher Sterne fur 1936, by R. Prager. (Ferd. Dümmlers Verlagsbuchhandlung, Berlin.)

This is the volume for 1936 in a series of similar volumes under the same authorship issued annually now for a number of years. It consists of about two hundred pages almost exclusively of tabular material. The volume for this year contains references to a total of 6776 variables, 555 of which are listed for the first time. The material is arranged in four sections as follows:

I. Catalogue of long-period variables arranged according to constellations (133 pages).
II. Elements of stars with periods less than one hundred days (18 pages).
III. Eclipsing variables (16 pages).
IV. Catalogue of variable stars arranged according to right ascension (32 pages).

This volume, as its predecessors, will be invaluable to all who have to do with the study and observation of variable stars.

Publications Received.—The publishers of POPULAR ASTRONOMY hereby acknowledge the receipt of the following named publications and express their great appreciation of the courtesy shown on the part of those who have sent them.

Contributions from the Mount Wilson Observatory:

No. 495. The Orbit of Boss 35 BR, by Elizabeth MacCormack.
No. 496. Temperature Classification of Infra-Red Iron Lines, by Arthur S. King.
No. 497. A Preliminary Survey of the Zeeman Effect in the Sun-Spot Spectrum, by Robert B. King.
No. 498. Spectrographic Studies in the Red, by Yngve Öhman.